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ELECTRIC DRIVE OF THE COKE-SHAKING SIEVE.

ELECTRICALLY-DRIVEN COKE CONVEYER.

ELECTRIC DRIVE OF THE CONVEYER IN THE COKE YARD.

AN ELECTRICALLY-OPERATED GAS PLANT.

AN ELECTRICALLY-OPERATED GAS PLANT.

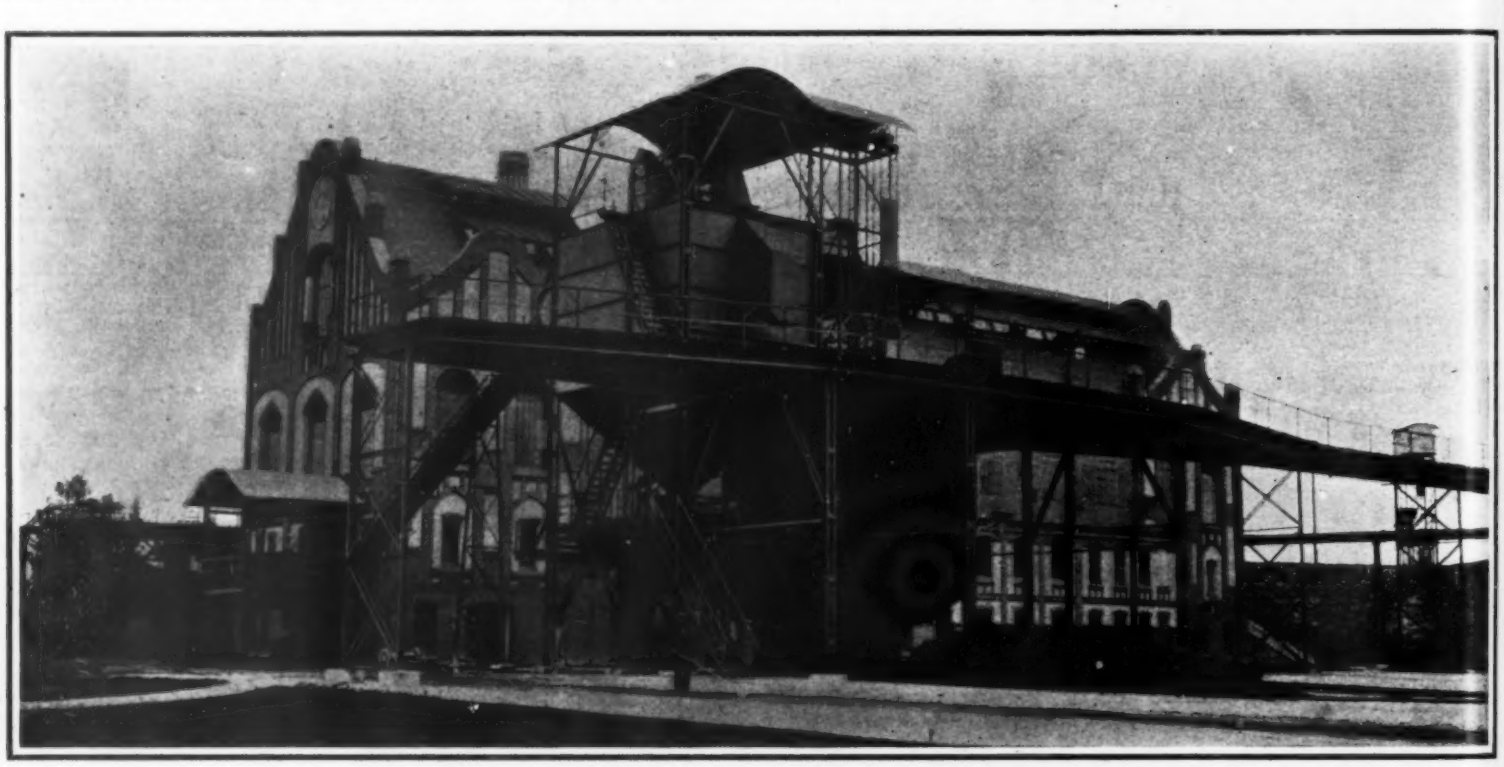
WHAT THE ELECTRIC DRIVE CAN DO IN GAS MAKING

BY DR. ALFRED GRADENWITZ.

THE extent to which electricity is utilized by some gas-works, which were formerly the keenest competitors of electric power stations, is exemplified by the municipal gas-works recently installed for the city of Görlitz, Germany, where direct current at 220 volts tension is generated in a special power house and distributed by a double conductor system. The installation comprises an extensive inside and outside lighting plant, covering the whole of the gas-works, in addition to a number of electric drives.

The electric power station contains horizontal tandem steam engines with valve gear and injection condenser, each of which yields a normal output of 125 horse-power, with 130 R. P. M., a maximum permanent output of 160 horse-power and a maximum temporary output of 190 horse-power. The engines are direct-connected with a direct-current dynamo of 110 kilowatts, the armature of which is carried on the extension of the crank shaft.

The boiler plant comprises four double-well tubular boilers of 910 square feet heating surface each, the steam pressure being 170.64 pounds per square inch.



COKE CRUSHING, CONVEYING, AND SORTING PLANT IN FRONT OF THE RETORT HOUSE.

AN ELECTRICALLY-OPERATED GAS PLANT.

A tower, installed beside the engine-house, serves to cool the condensing water, the cooling water being raised by a centrifugal pump, operated by a directly connected electric motor of 5 horse-power capacity.

Outside of the boiler and engine rooms, the power house comprises an accessory hall accommodating the water cleaners and steam feed pumps, in addition to a common wardrobe and washing room for the staff. The engine room has been given ample dimensions to accommodate a third steam-driven dynamo, while space for two additional boilers has been provided in the boiler room.

The switches are arranged on a masonry pedestal on one of the short sides of the engine room, and are mounted on five panels. The space required for installing any apparatus entailed by a future extension has been provided for. All fuses for upward of 40 amperes are arranged behind the switchboard, where the shunt regulators of the dynamos, operated from the front by means of hand-wheels, will likewise be found. Connection between the dynamos and the switchboard is effected by iron-armored tables, laid out below the ceiling of the engine house cellar on a corrugated sheet base.

The lighting plant comprises 125 incandescent lamps and 20 arc lamps, the latter being arranged in five circuits of four each as follows: 2 arc lamps of 10 amperes each both in the engine and boiler rooms; 4 arc lamps of 10 amperes each in the coke yard; 8 arc lamps of 8 amperes each in the oven house, and 1 arc lamp of 10 amperes for the coal-dressing plant, railway embankment, gas reservoir, and power house respectively.

Electric motors have been used most extensively for the operation of the most varied auxiliary machines, to an aggregate yield of upward of 100 horse-power. The most important drives, for each of which a special electric motor has been provided, have the following capacities: The coke driving and hauling plant close to the oven house, 18 horse-power; the coke chute in the oven house, 6 horse-power; the coke chute of the coke crushing and sorting plant, 17 horse-power; the coke-shaking sieve below the night reservoir, 2 horse-power; the coke chute above the night reservoir, 5 horse-power; two coke elevators of 4 horse-power each; a high-pressure blower, 25 horse-power; a tar centrifugal and an air pump in the ammonia room, of 5 horse-power, etc.

Those electric motors which, while protected on top by corrugated sheet roofs, are otherwise isolated, are of the entirely inclosed type, the starter and switch-boxes of each of them being located in a sheet metal cupboard, fitted with sliding doors. The motor driving the air pump in the ammonia room is likewise entirely inclosed, while that operating the tar-centrifugal is surrounded by a ventilated housing, sufficient air being supplied through tubes.

Four main feeders branch off from the switchboard at the central station, two of which are intended for lighting and two for power supply. In addition to these, a number of smaller circuits have been provided, especially for the lighting of the power house and for some smaller motors.

The capacities of the motors located in the neighborhood of the oven house, especially those intended for the coke crushing and sorting plant, as well as the lighting conductors supplying the oven house, have been designed as underground cables, and all the remaining conductors, in so far as they are situated outside the buildings, as overhead conductors.

Most of the conductors traversing the buildings are located in pipes, rubber strands in steel-armored pipes being used in all rooms subject to the risk of explosion, in accordance with the regulations of the Association of German Electricians. All the switches and fuses are arranged outside those rooms. The lamp filaments, which are fitted with porcelain armatures and inclosed globes, are screwed directly to the piping and the lamp pendulums through the intermediary of gas-tight ball joints.

A remarkable performance in mining work is recorded in the South African Mining Journal. At the Simmer Deep, a Rand property, two miners carried a drive 294 feet in sixty-one consecutive shifts of ten hours each. The size of the drive was 5 feet by 7 feet. One white man and six Chinese were employed on each shift, and one round was drilled per shift, each round gaining an average of 4.82 feet. The number of feet broken per case of gelatine consumed was 4.52, and 11.06 pounds of gelatine were used per foot. Of the 61 rounds drilled, 59 had 14 holes each and two had 12 holes each. The nature of the ground driven through is not mentioned.

THE WORLD'S LUMBER TRADE.

FEW people have the slightest conception just how important a part timber and unmanufactured wood play in the trade between the world's great nations, and doubtless it is news to many to learn that the lumber importations of the various countries amount to $285,600,000. This is according to estimates for the whole world compiled by Dr. Ernest Friedrich of the German commercial high school at Leipzig.

Notwithstanding the fact that it finds its own supply dwindling, the United States furnishes about 20 per cent of the lumber imported by other countries. Austria-Hungary furnishes 19 per cent, Russia 16 per cent, Canada 13 per cent, Sweden 18 per cent, Finland 10 per cent, and Norway and Roumania a small quantity.

The countries importing wood are those on the highest economical plane, which were themselves in earlier times densely wooded, but whose forests have been denuded to a greater or less extent to make room for agriculture and other industries, says Vice-Consul James L. A. Burrell, of Magdeburg, in a report to this government. Only 4 per cent of the territory of Great Britain is covered with forests, and during the year 1906 that country imported lumber to the value of $135,561,750. Germany has still 26 per cent of its territory covered by forests, but imported in 1906 lumber valued at $61,285,000. Belgium and the Netherlands, that have but 8 per cent forest lands, Denmark that has 7 per cent, France and Switzerland, with a small percentage, are all compelled to import lumber.

Besides these countries, those lands lying on the dry western side of the sub-tropical zone lacking forests are forced to import wood. Egypt imports wood and coal to the value of about $16,660,000 annually; Algeria, Tunis, Spain, Portugal (with only 3 per cent forest land), Italy, Greece (with 9 per cent forest land), the eastern part of Asia, British South Africa, the western part of Chile and Peru, the Argentine Republic, and Australia, all poor in wood, are dependent upon import.

EXTRACTING OIL FROM BOREHOLES.

A DESCRIPTION OF THE LEINWEBER PROCESS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

AT the Kryg oil field of the Galicia-Carpathian Petroleum Company in Austria there has recently been installed the first machine for the extraction of oil from boreholes founded upon the novel system evolved by Mr. Bruno Leinweber, a well-known engineer of Vienna. This system is simplicity itself, and is designed for operation on those fields where "spouting" does not take place, and to avoid the laying down of elaborate pumping installations to draw the liquid to the surface. Owing to the isolated situation of the Kryg oil field, the utilization of the ordinary types of plant for obtaining the oil in such circumstances is somewhat risky, since in the event of a breakdown the whole work would be brought to a stop until the repairing or renewal of the parts could be effected, which in view of the inaccessibility of the oil field, would occupy several days.

Briefly described, the Leinweber system consists of the lowering of a band of suitable material into the borehole and the passing of it through the liquid, whereby a certain quantity either becomes absorbed by the cable or clings to it, by which means it is hoisted to the surface and squeezed out by passing between rollers, the extracted oil falling into a suitable receptacle below. By connecting the ends of this band together, an endless cable is procured, which together with a continuous drive enables extracting to be carried out uninterruptedly. The principal advantages of this system are that the band can be lowered into the narrowest fissures, the width of the band being designed to suit the conditions. The simplicity of the apparatus in both design and operation reduces the risk of breakdown to the minimum. Its applicability to the raising of any description of crude oil, whether thick or fluid, irrespective of the presence of sandy or other foreign substances which in a pumping plant are liable to cause clogging of the apparatus, is universal. Its highly efficient yield is secured with the minimum of expense.

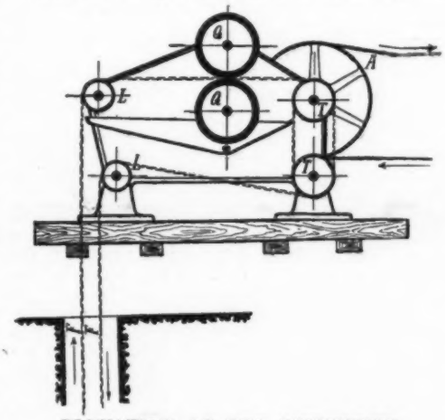
The general design of the apparatus may be gathered from the accompanying diagram. The endless band traveling up and down the borehole is represented by *F*, in the pit, the lower end passing through the oil deposit. The ascending cable after issuing from the borehole passes over the upper pulley leader *L*, then between the pressing rollers *Q*, round the winding sheave *T*, and thence into the borehole again over the lower pulley leader *L*, the mechanism being driven through the pulley *A*. In the case of the apparatus for the Kryg oil field, a few minor modifications had to be made in this design to coincide with local requirements, but fundamentally the principle is the same throughout. As will be seen, the whole of the apparatus is carried upon a timber frame, which can be placed at any desired height above the ground. The Kryg apparatus was constructed in the railway workshops at Reichenberg, Bohemia, under the superintendence of the railroad engineer Mr. Oskar Forster, and was sent to the oil field ready for instant use upon arrival. The fact that the mechanism can be dispatched to any inaccessible point ready for immediate operation constitutes a prominent feature of the invention.

The endless band employed has flattened sides similar to those used on elevators, and up to depths of 1,640 feet is manufactured of hemp, being 3 inches wide by 0.31 inch thick, having a breaking strain of 9,240 pounds. This band is covered with carpet shag 2.36 inches wide by 0.078 inch thick, the pile of which offers a greater absorbing surface to the oil. For depths exceeding 1,650 feet a steel wire band is preferable to the hempen cable.

At Kryg, however, a shorter length of band had to be ultimately used on the occasion of the inventor's first tests, owing to the severe frosty weather which prevailed at the time. The borehole is 2,000 feet deep, by 9 inches in diameter, but only the upper part of the pit could be used. Owing to the heavy snowfall, the carpet shag had become heavily clogged and frozen, and so was not very pliable, and had to be lowered with great care into the pit, an operation which occupied in this instance ninety minutes. Owing to the necessity of operating the winding jack by means of the hand crank, a speed of only 8 inches per second was attained. The weight of the band served to keep it well stretched downward, so that in traveling up it did not come into contact with the sides of the borehole. After the band had been revolved a few times it became softer and more flexible.

As a rule, after passing through the mangling rollers the nap of the carpet shag is carded out, but on this occasion the operation was dispensed with. Owing to the severity of the weather the oil, which contained a good percentage of paraffin, was of the consistence of fruit jelly, so that the absorbent efficiency of the rope was considerably reduced. Despite these disadvantages, however, it was found that the yield was about 4.86 ounces per foot, which is equivalent to 658 pounds per hour. In this case, moreover, the yield might have been much greater, because a large quantity of oil which can be removed only by passing the band between scrapers, is raised clinging to the edges of the band. This operation was omitted, so that a considerable quantity of oil returned again into the borehole. The frozen nature of the band, too, somewhat militated against the complete success of the test, since it was some time before the band became pliable and able to exert its maximum absorbent capacity. Furthermore, the speed of driving, owing to manual labor, dropped to 5 inches per second, but this was sufficient to fill an ordinary barrel in fifty minutes. As the band became better adapted to the work, the yield increased to 6.13 ounces per foot = 763 pounds per hour. Subsequently steam power supplanted the manual labor, and at a speed of 3 feet per second the output at 6 ounces per foot rose to over 3,518 pounds per hour, giving a total yield per day of twenty-four hours of 84,432 pounds.

Owing to the complete success of these tests, the



ELEVATION OF THE LEINWEBER APPARATUS.

apparatus was dismounted and conveyed to another borehole in the vicinity belonging to the company, and re-erected where it is now operating continuously to a depth of 2,000 feet.

It has been found necessary to reduce the absorbing capacity of the band, since when operated under the most economic conditions, the yield of the apparatus exceeds the capacity of the borehole. For instance, with a band approximately 5 inches in width by 0.5 inch thick, covered with shag having pile one inch in thickness and driven at 15 feet per second, the yield is 3.66 pounds of paraffin per foot per second, which is equivalent to approximately 396,000 pounds per hour. Since the construction of the machine above described and now in operation at Kryg, the inventor has considerably reduced the proportions of the band, and at the same time reduced the driving speed, so that the band may be rendered more durable with an added freedom from breakdown. Owing to the nature of the material used for the band, it can be lengthened or shortened according to requirements with facility and expedition, since the joints are effected merely by cobbler's thread sewn either by hand or by an ordinary saddler's machine. It has been found too that at no matter what speed the apparatus is driven, there is always a comparative absence of vibration, and that as the band becomes saturated with oil it runs still more smoothly, with an increased adhesion at the winding sheet, with less stiffness in the rope. Owing to the increased weight of the oil-charged ascending rope, it maintains an almost vertical line in the borehole, so that no losses are incurred by friction with the sides of the pit. The Kryg machine before being sent to the oil fields was submitted to severe tests with an overload of 2,500 pounds beyond the 550 pounds which was the stipulated weight of the ascending cable when charged with oil, and the band did not show the slightest signs of slipping or jerking during elevation to the surface at the highest speeds.

The operation upon the Galicia-Carpathian oil fields has been attended with complete success, causing the device to be recognized as far superior to the ordinary pumping methods of raising the oil to the surface. The presence of sand in the pits does not interfere with its operation in the slightest degree, and it can be applied to any type of borehole, no matter of what diameter, it only being necessary to accommodate the dimensions of the rope to the size of the pit. Its efficiency can be regulated within wide limits by speeding up or reducing the drive as desired, or by enlarging or reducing the width of the rope and the thickness of the pile covering, while the denser the fluid it has to raise, the greater the yield per foot at normal speeds. Owing to the simplicity of the mechanism there is nothing liable to derangement, the only wearing part being the band itself. This can be repaired whenever desired without dismounting the cable, either by cutting out the defective section entirely, or by sewing on new pieces of shag, or bundles of thread, which are equally efficient.

The withdrawal of the band from the borehole or its insertion is easily and speedily effected. For the former the descent of the cable is arrested by securing it to the frame of the machine, and the engine continues hoisting up the ascending rope, which can be coiled on the ground as it issues from the winding sheave; for the reverse operation, the ascent is arrested and the running of the engine merely permits the band to descend until it has gained the requisite depth. Should there be any water in the borehole, this is drawn up with the oil and eliminated by passing through the pressing rollers, the oil falling into the receptacle beneath and the water being carried off through a conduit; similarly, any sand that may be suspended in the oil can be removed by means of a water or steam flush. Owing to the continuous movement of the band, the possibility of the borehole's becoming obstructed at any point in its depth is obviated. Should the band suddenly break while running it is not lost, since it passes thrice round the winding sheave before descending into the pit; and by means of a safety clutch and special attachment, directly the band breaks, the upper end is caught and held secure until the lower extremity is again brought to the surface. Similarly, should any untoward resistance be imposed upon the band, the winding sheave is immediately stopped. Owing to the two sections of the band—the ascending and descending respectively—being the same length and consequently of the same weight, when dry, they balance one another. The driving engine has thus only to be sufficiently powerful to hoist the weight of the oil saturating the rope, together with the slight frictional losses that arise. Once set in operation, the apparatus requires no further attention whatever beyond the periodical inspection of the cable, which can be followed while traveling, so that it can be run night and day without cessation.

REBUILDING OF A SUNKEN BRIDGE ABUTMENT WITH CONCRETE STEEL.

THE abutment of a railway bridge on the line of the Marriout Railway, in Egypt, sank at the loading test. It has been successfully rebuilt of reinforced concrete. The bridge crosses a feeding canal of the Marioti lake, in which empty a great number of muddy irrigation canals of the province of Behera. The ground is therefore very unfavorable for a foundation. An examination of the soil down to 50 feet under the mean water level showed gray mud 9 feet, sticky mud with fragments of broken shells to 24 feet, limestone to 25 feet, hard clay to 37 feet, compact sand to 45 feet, loose sand to 50 feet.

The abutment was built by the "Compressol" method, which has been described in the SCIENTIFIC AMERICAN, i. e., by a falling weight compressing the soil downward and sideways, the hole so made being filled with concrete. Ten such holes were sunk under each abutment, and were connected by a 3¼-foot concrete-steel slab. Upon this slab the pier rested. The load carried by the slab was only 240 tons, or 24 tons per pile. At the conclusion of the loading test, made with three locomotive engines with their respective tenders, the northerly abutment suddenly sank 4 inches deep and then gradually deeper to 3¼ feet, leaning over toward the land side, without the concrete showing any cracks. This accident was ascribed to the overcoming of the adhesion between mud and concrete, or to the building of a mud wave under the foundation.

To repair the structure, the upper part was removed and the abutment uncovered. The steel structure was raised from the pier by means of a wooden scaffolding and a cofferdam built around the pier, and the pier taken down to the foundation. This was surrounded by a ring of 34 piles, 46 feet long, driven into the sand. These wooden piles were cut 4 inches under the lowest water mark, and the heads bound together by steel rods. The ground inside of the ring was then excavated to 8 feet below the water level, and a layer of bowlders thrown into the excavation to make a solid foundation.

A concrete-steel slab was now cast on top of the stones, covering the piles. The reinforcement consisted of five rods, 0.76 inch in diameter, laid on the upper as well as on the under side of the slab. Connection was made with the old foundation by boring into the slab three holes and putting through them three 1.28-inches steel rods, firmly anchored to the new foundation. Over the old foundation 0.76-inch steel rods were laid, 16 inches on centers, also anchored to the new foundation. Upon this new foundation was built a pyramidal concrete body completely enveloping the old abutment and carrying the new spandrel wall.

The concrete consisted of old broken clay vessels, called chakf, sand, and Portland cement.—Dingler's Politechnische Rundschau.

TESTING DIRECT-CURRENT DYNAMOS.

HOW TO MEASURE INSULATION RESISTANCE AND DETERMINE THE CHARACTERISTICS OF A DYNAMO.

BY E. S. LINCOLN.

THERE are several methods of measuring the insulation resistance of a direct-current dynamo, but the most convenient and practical method is known as "the voltmeter test for insulation resistance." To obtain good results with the voltmeter test a voltage of 500 or over should be available, or at least a voltage equal to that at which the machine is rated. The resistance of the voltmeter must be known, of course, and this can be found on the inside of the case, if a Weston voltmeter is used. For a 150-volt instrument of this type the resistance is about 15,000 ohms; that of a 600-volt instrument is between 60,000 and 80,000 ohms.

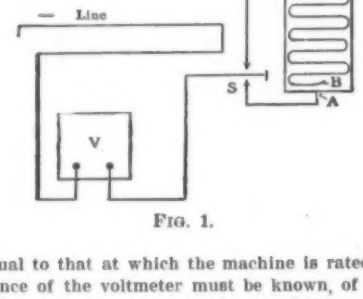


FIG. 1.

The test is very simple. The voltmeter is connected across the source of current and the deflection noted. The instrument is then connected in series with the frame of the dynamo (be sure this connection is perfect) and the circuit completed by connecting the other side of the line with a terminal of the machine. The connections are shown in Fig. 1, where V is the voltmeter and S a single-pole double-throw knife-switch. By throwing the blade up, the line voltage can be obtained; for the second reading, it is thrown down. The frame of the machine is represented at A, while B indicates the free terminal of the winding.

The insulation resistance is calculated from the formula

$$X = R \times \frac{D-1}{d}$$

in which X = the insulation resistance, R = the resistance of the voltmeter, D = the first, or highest, deflection of the voltmeter, and d = the second, or low, deflection. Not more than one-millionth of the rated current of a machine should pass through the insulation at its normal voltage. To illustrate the use of the formula, assume that the 150-volt instrument

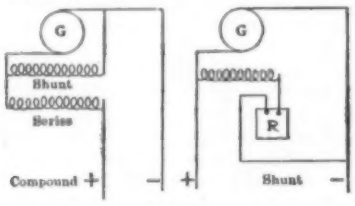


FIG. 2.

indicated 110 volts when connected to the line and a deflection of 1.5 volts on the second reading; then,

$$X = 15{,}000 \times \frac{110-1}{1.5} = 1{,}090{,}000$$

ohms of insulation resistance. To obtain the insulation resistance under normal running conditions, it should be done when the machine is thoroughly heated.

Where a number of dynamos are to be tested for insulation resistance, marks indicating varying amounts of resistance may be permanently located on the voltmeter scale, the following formula being employed to determine them:

$$d = \frac{110\,R}{X+R}$$

in which d = the number of volts, opposite which should be placed the corresponding graduation to form the new scale; R = the resistance of the voltmeter, X = the insulation resistance, and 110 = the voltage used in all the measurements. (In this case 110 is used for illustration, only, and can be replaced by any other value, preferably a higher one.) The insulation resistance should be indicated in megohms, ½ megohm, ¼ megohm, etc., so as to avoid long numbers on the scale. In using such an instrument, calibrated in this way, the same voltage must be used when testing as when the graduations were made.

The insulation resistance of the armature and fields may, of course, be tested separately, first disconnecting them electrically.

The first step to be taken in testing a dynamo is to determine its rating, and the second step is to locate all its connections. In Fig. 2 are shown the connections of both shunt and compound-wound types. The shunt windings comprise numerous turns of comparatively small wire, while the series winding consists of a few turns of large wire in small machines, heavy bar copper being used in large machines instead of wire coils. By locating the windings and their connections with the brushes, it is an easy matter to determine the kind of dynamo. In Fig. 2 the position of the rheostat in the shunt-wound machine is shown to illustrate why three wires are usually run to a machine instead of two or four. A series-wound machine has no shunt winding and is connected in the same manner as the compound-wound dynamo in Fig. 2, omitting the shunt field winding.

It sometimes happens that the nameplate on a dynamo does not indicate its rating, or perhaps the nameplate has been removed and is lost. In such case, one can get an idea as to the output by examining the windings. If it is a compound-wound machine and its series winding is composed of very large wire, with few turns, while its brush and commutator are large, compared to the size of the dynamo, it will probably deliver a low voltage and high amperage. Conversely, in most cases a fine-wire winding with many turns in the shunt field indicates a high voltage. A high-speed machine will have a small armature as compared with its field-magnet, which will have few poles. When the field-magnet and armature are about the same proportions, the machine will probably run at medium speed. A low-speed machine will have a large armature in comparison with its field-magnet, which will have a number of poles. These deductions apply to dynamos of equivalent capacity. Judgment of the output and speed of dynamos formed in the manner outlined is, of course, only approximate. Any speed up to 600 revolutions per minute might be considered low for small machines, from 600 to 1,000 revolutions per minute would be medium speed, and above 1,000 revolutions per minute high speed. For large machines the figures would be reduced nearly 50 per cent. Accuracy in estimating will depend chiefly upon experience in dynamo design and operation, and the ability to reason.

Incandescent lamps will be found convenient for determining voltage. By starting with a number of lamps in series and gradually cutting them out, a good idea of the voltage of a dynamo can be obtained. For instance, ten 100-volt lamps in series would require 1,000 volts to burn each lamp at its rated candlepower. By short-circuiting one lamp at a time the approximate voltage of the line can be regulated, if each lamp is burning at or near its rated candlepower.

There are three characteristic curves for every dynamo—the internal, the external, and the total. The internal characteristic curve shows the relation between the current and electromotive force in the machine circuit, its armature, field winding, etc. The external curve indicates the relation between the amperes and volts delivered to the external circuit supplied by the dynamo, such as the amperes and

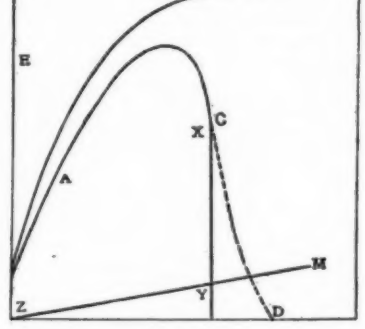


FIG. 3.

volts delivered to a power or lighting circuit. The third, or "total" curve, takes into consideration the total current and voltage, i. e., both the internal and external. The shape of the characteristic curve depends upon the method of connection between the armature and field winding of the generator. These curves are plotted on cross-section paper and the usual method is to plot the volts on the vertical lines, as ordinates, and the amperes on the horizontal lines, as abscissas. In many cases these curves can be figured out mathematically, but the most accurate method is to test the finished machine.

Referring to Fig. 3, the curve A represents the external characteristic of an arc-light series generator. It will be noticed that the curve does not start at the origin. This is due to the fact that a small amount of magnetism remains in the field-magnet. This is termed "residual magnetism." Without this magnetism it would be impossible for the machine to start up under its own excitation. The curve runs up very steeply until the iron in the field-magnet approaches the point of saturation. The load is increased until the machine is finally short-circuited. The curve

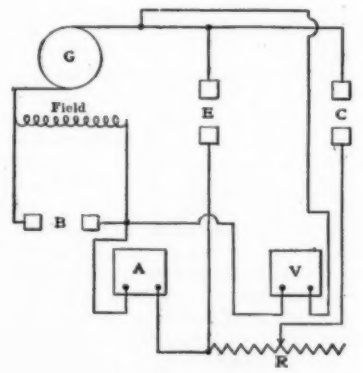


FIG. 4.

drops in a straight line, due to a governor which changes the position of the brushes. It is upon this portion of the curve, from X to Y, that the load, which usually consists of arc lamps burned in series, is carried. The dotted line C-D represents the characteristic that would be obtained if the position of the brushes were unchanged. It will be seen that the machine delivers a constant current, with its voltage varying to suit the resistance of an external circuit. The curve B is the "total" characteristic curve,

and is obtained by multiplying the current by the internal resistance of the machine and adding the result to the voltage of the external characteristic. These values can be taken from the loss line described later.

Great care must be taken, when obtaining these curves from a series machine, that the circuit is never broken, as the voltage will rise to a very high value, due to the self-induction of the armature and field-magnet. The connections for a series machine are shown in Fig. 4 where *G* is the generator, *A* is the ammeter, and *V* is the voltmeter. A variable resistance is represented at *R* and should be so arranged that

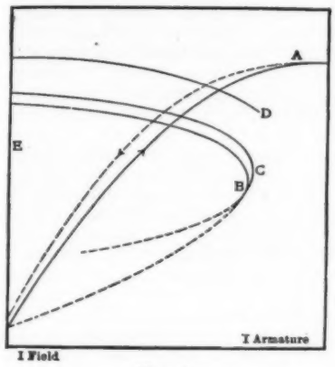


FIG. 5.

the circuit will never be broken. The switch *B* is used to short-circuit the field winding in case it is necessary to adjust connections or make changes. The ammeter and voltmeter readings should be simultaneous. Before starting, see that the generator and governor are in perfect condition and that the machine is properly connected to the circuit. The speed throughout the run must be kept constant. The first reading is taken with the switch *C* "off," to get the voltage at which the curve is to start. The switch *C* is then closed and the variable resistance *R* is gradually cut out, readings being taken at various points in the resistance to obtain a smooth curve. When the last point is reached the switch *E* is closed to short-circuit the machine, and this will give the last point on the curve. In this last reading the voltage will be zero, but the current will vary little from the other reading, if the governor is in proper working order.

In starting such a test it must be seen that the current is passing through the field winding in the proper direction for the machine to "build up." If this is not the case, simply reverse the terminals of the winding.

The line *M Z*, Fig. 3, is the resistance line of the dynamo. This line is obtained by multiplying the known internal resistance of the generator by the different currents, given as abscissas. Only one value is necessary, however, to determine the loss line, and an illustration will be of assistance. Suppose the resistance of the generator, measured at its terminals, is found to be 3 ohms. (This measurement should be made after the run when the machine is at working temperature.) Multiply the resistance of 3 ohms by, say, 10 amperes, which gives 30 volts. Then find a point on the plotting paper which corresponds with 10 amperes and 30 volts. From this point draw a straight line to the origin, and this will be the loss line. The resistance of the machine is obtained by the drop method already described. It may be neces-

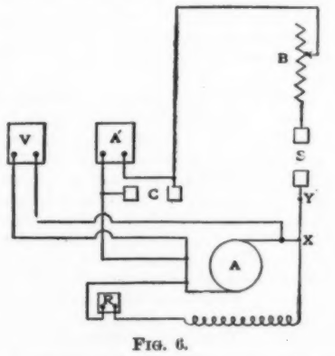


FIG. 6.

sary to block the armature to prevent it from running as a motor in the reverse direction. Each reading of the instruments must be carefully noted, and it is important that readings should not be repeated, as the same values cannot be obtained on account of the hysteresis of the field-magnet.

The internal characteristic curve of a series dynamo is obtained by plotting the voltage of the armature and the current in the field winding, but it is necessary, of course, to excite the field-magnet by means of an adjustable current taken from some separate source.

The characteristic curves of a shunt-wound dynamo are shown in Fig. 5. The curve *A* is the internal characteristic or magnetization curve of the generator. It is obtained by plotting the current in the field winding as abscissa and the volts at the terminals of the machine as ordinates, the machine running free. This curve is similar to the characteristic curve of a series machine. It bends over as the current increases, due to the field-magnet nearing the point of saturation. If increased, it would run in a practically straight line. The dotted line back of the curve *A* represents the values when the current is decreased, using the highest readings as a starting point. This peculiar condition is due to the residual magnetism of the iron in the field-magnet. The curve *B* represents the external characteristic and is obtained by plotting the current delivered to the external circuit as abscissa and the voltage at the brushes as ordinates. This curve tends to bend backward as the load is increased. The voltage drops, due to the resistance of the armature, or more properly the *I R* or amperes × resistance drop of the armature. This decrease in voltage allows less current to flow in the field winding and in turn still further decreases the voltage of the dynamo. If the voltage at the field-winding terminals were kept constant the curve would not bend backward, but would take the form of the curve *D*, which represents the armature characteristic. The drop in this curve is due to the resistance of the armature only. From the foregoing it can be seen that the peculiar bend in the external curve is due to the drop in voltage at the field-winding terminals. In large dynamos the values of the bending portion of the curve cannot be obtained, as the large amount of current flowing in the armature would be liable to injure it.

The "total" characteristic curve is indicated at *C* and is obtained by adding the current in the field winding to the value of the current in the external circuit. In order to obtain the voltage of the total characteristic, the resistance of the armature must be known and this multiplied by the different values of current will give the total voltage.

The internal characteristic or magnetization curve is obtained by running the machine without load and plotting the voltage at the brushes, and the current in the field winding. The field-regulating rheostat and a low-reading ammeter are connected in series with the fields. The speed of the machine must be kept constant. Starting with the field circuit broken, the origin of the curve is obtained. The voltage at this point is due to residual magnetism, as previously stated. Gradually cut the resistance out and take readings at enough points to get a smooth curve. It is important that this circuit should not be broken unless all the resistance is in the circuit. Never repeat readings, but if a mistake is made start the whole curve over again, after waiting a few minutes for the magnetism to return to its former condition.

The connections for the external characteristic curve are shown in Fig. 6, where *A* indicates the armature of the generator. The current passes from the brushes to a switch *S*, and then enters the variable resistance *B*. The form of resistance used, whether lamps, wire or barrel, will depend upon the size of the dynamo. The ammeter and voltmeter are represented at *A'* and *V*, respectively. The field rheostat is shown at *R*, connected in the field circuit, which should remain unchanged after the voltage has been equalized with that at which the machine is rated. The generator is first brought up to its rated speed and its voltage properly adjusted. Before starting be sure that the machine is in perfect order and properly oiled. When everything is ready close the switch *S*, making certain that all the resistance is "in" at the variable rheostat *B*. Open the short-circuiting switch *C* and determine whether the ammeter is properly connected in the circuit or not. If the wrong polarity exists cut the instrument out and reverse its leads. With the switch *C* open, gradually cut out the resistance *B* until the machine is overloaded about 50 per cent, being careful that it does not get too hot. When the highest reading has been taken, unload the machine and break the circuit. The speed throughout the test should be kept as constant as possible, readings being taken at frequent intervals and recorded.

Referring again to Fig. 5, once more note the drop in voltage as the load increases. If the field current should be increased in proportion as the load increases, a straight line would be the result. The object of the series winding is to furnish this increase in the magnetizing power and raise the voltage of the armature. Its effect is like that of an automatic rheostat which increases or decreases the field strength according to the load on the generator. In most cases, however, it is desired to increase the voltage of the generator in order to compensate also for line losses. The dynamo is then said to be over-compounded, the compensation necessary varying by from 2 to 15 per cent, according to the class of service. In this case the curve would rise as the load increases; in the case of a 500-volt machine over-compounded to compensate for a 10 per cent loss, for example, the voltage would be 550 volts at full load. The percentage of compensation furnished can be varied by shunting the series winding, as shown at *S*, Fig. 7. The current will then divide, part flowing through the series field winding and the remainder through the shunt which usually consists of German-silver ribbon. This method of regulating the compounding is useless when machines are to be operated in parallel, but works satisfactorily with a single machine.

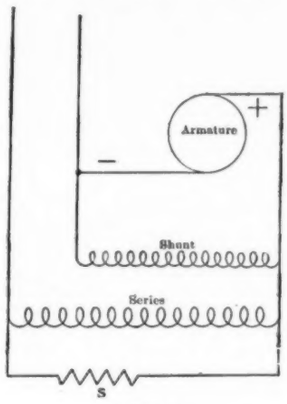
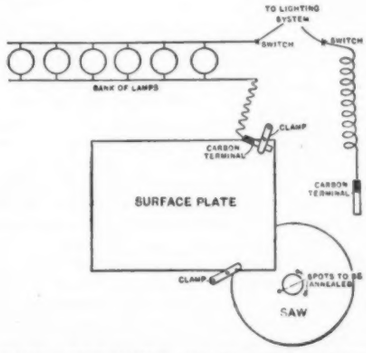


FIG. 7.

The curves for these machines would be obtained in the same way as for the shunt-wound machine in Fig. 6. The only difference would be that the series field coils would be in series with the line at the points *X* and *Y*. *X* representing the brush terminal, and *Y* the terminal of the dynamo. The voltmeter lead would then be connected at the new terminal of the machine, or at *Y*. The dynamo would be of the "short-shunt" type with the connection as shown, and of the "long-shunt" type if the shunt field winding were connected at the point *Y*, thereby causing the shunt field current to pass through the series winding. In practice it makes very little difference which method of connecting the shunt winding is used, as both give practically similar results.—Power.

SAW ANNEALING BY ELECTRIC ARC.

A CONTRIBUTOR to the Electrical World describes how in a simple manner the electric arc may be utilized for annealing the center of a circular saw. For a certain milling operation it was necessary to use a 4-inch saw, 1/16 inch thick, so close to a projection on the work that it could not be supported on more than one side. A special arbor was made with a shoulder, and the saw was soldered in place. The heat of the solder, however, made the saw buckle, and it broke loose after milling a few pieces. It was then decided to anneal the center of the saw, and fasten it to the end of the arbor with button-head screws. The device shown in the cut was used for the annealing. This device consisted of two pieces of arc light carbon connected up to the lighting system, which was 110-volt direct current, with six 16-candle-power lamps arranged so that one or more could be put in the circuit for resistance. The spots to be annealed were marked on the saw, and it was then clamped to one edge of a small surface plate. One of the carbon



SAW ANNEALING BY ELECTRIC ARC.

terminals was also clamped to the surface plate, and after turning on the current, the other carbon was held just far enough from the spot to be annealed to cause a good arc. This was continued until the spot was judged to be hot enough, and then the other spots were treated in the same manner. The result was so successful that the saw was easily drilled and countersunk at the annealed spots, and the screws put in flush with the side of the saw.

CHANGES IN THE EARTH.*

HOW RADIO-ACTIVITY HAS AFFECTED ROCKS.

BY THE HON. ROBERT JOHN STRUTT, M.A., F.R.S.

THE source from which radium is obtained is the mineral pitchblende. This mineral occurs in veins, like the majority of useful metals; I may refer particularly to the mineral veins of Cornwall, so long famous as a source of tin. These veins are of the nature of cracks, running through the granite and through the slate which adjoins it. The cracks have been filled up by the various metallic ores which have been introduced by precipitation or sublimation, the exact nature of the process being somewhat obscure.

An experiment, due to Sir W. Crookes, illustrates the radio-activity of pitchblende in a very beautiful manner. A flat polished slab of pitchblende intergrown with a variety of other material which is not radio-active was laid face to face with a photographic plate, which was developed after the lapse of about a week of contact. The radium and other radio-active substances contained in the pitchblende have acted photographically upon the plate, while, of course, those portions of the material which are not radio-active have exerted no such action. Thus pitchblende has, as it were, taken its own portrait.

Pitchblende, the principal radium ore, contains only an infinitesimal percentage of radium, the bulk of the substance being made up of oxide of uranium. Uranium is commonly spoken of as a rare metal; but terms of this kind are comparative only, and in contrast with radium, which is more than a million times scarcer, it seems common enough. Now I wish to speak for a little about this association of uranium and radium in pitchblende. Is it accidental, or has it some special significance?

In the early days of radium, it was common to hear the difficulty emphasized, that while there was no reason for doubting that the radium which was found in the earth had been there as long as other metals, a substance that was continually giving out energy in this way was obviously defying the greatest physical generalization of the nineteenth century—the law of conservation of energy. We cannot, however, afford to sacrifice this law so easily, and a ready mode of escape offers itself, if we suppose that a continual waste of radium is occurring. In that case it becomes necessary to suppose also that the supply is in some way replenished, for otherwise all the radium would have wasted long ago. From what material are the fresh supplies of radium derived? They must be derived from some other substance contained in the mineral where the radium is found, and there is now reason to feel sure that uranium is the substance in question.

We have convincing proof of this, in the fact that the amount of radium found in the mineral is always in direct proportion to the quantity of uranium which it contains. I should perhaps say, to avoid misconception, that there is good reason for believing that several transitional stages exist through which uranium passes on its road to become radium. It is not necessary, however, to take into account the existence of these intermediate products in order to form a clear idea of the process by which the supply of radium is kept up. Uranium changes spontaneously though very slowly into radium, and the amount of radium produced per annum, for example, will be proportionate to the amount of uranium present. On the other hand, a certain fraction of the total amount of radium present decays per annum, and the balance of this account of profit and loss will represent the amount of radium found in the mineral at any time that we examine it. There will be no difficulty in seeing that on this theory the amount of the radium in the mineral should be proportionate to the amount of uranium, and experiment fully confirms the theory by showing that such is in fact the case. We have here a clear and distinct case of the transmutation of metals, so long unsuccessfully searched for.

Let us now come back to the pitchblende.

What was the source of metalliferous ores found in mineral veins is a very much vexed question, and no solution of it which has yet been proposed can be said to be altogether free from difficulty. One of the most plausible theories, however, supposes that the metals have been derived from the rocks by which the veins are traversed. We are not here concerned with metalliferous ores in general, but only with those which carry radio-active material. In deciding whether the granite of Cornwall can be supposed to furnish the uranium of pitchblende, it is, of course, fundamental to know whether any uranium is present in the rock. It should be said, by way of preface, that the quantity must, at best, be very small, and certainly too small for detection by the methods of chemical analysis as ordinarily applied. We have seen that uranium in nature is invariably accompanied by a proportionate quantity of radium, and as it is in practice much easier to detect minute quantities of radium than to detect the corresponding quantities of uranium, it is best to look for the former only, and to be content to infer the presence of the latter.

I have made a large number of experiments to find out how much radium there may be, not only in Cornish granite, but in a large variety of other rocks. In every case the presence of radium has been established, though only to the extent of about one-millionth part of what is found in pitchblende, and even that, it will be remembered, is not much. If we take into account the very large bulk of the granite and the very small bulk of the pitchblende veins running through it, there is no difficulty in admitting that the granite was capable of supplying the radio-active material of the pitchblende.

Granite, of course, consists of a variety of different minerals, which give it its mottled appearance. These minerals, there is no reason to doubt, have been formed in the successive stages of crystallization of an originally molten mass. There is a mineral called zircon, of which the jacinths sometimes set by jewelers are a variety, which is present in very minute crystals in granite. These minute crystals of zircon have a very characteristic geometrical shape; a square prism terminated at each end by a pyramid, as you see in the photograph. The fact that they have this perfect shape is a proof that they have been perfectly free to assume their natural form, and have not been hampered for want of space by other minerals surrounding them. The inference is plain that zircon has been one of the first minerals to crystallize in the consolidation of granite.

I have found that this zircon is very much richer in radium than the granite generally, though, on the other hand, it is poor compared with pitchblende. It seems clear that the minerals which crystallize first take an unfair share of the radio-active elements, leaving the rest of the magma impoverished.

In the light of this observation, Prof. Joly, of Dublin, has been enabled to explain a curious appearance which is seen when a section of the granite thin enough to be transparent is examined under the microscope. One of Prof. Joly's photographs shows a minute crystal of zircon, which is imbedded in a large crystal of mica. The material surrounding the zircon for a definite distance outward has become darkened in color. The altered region round the speck of zircon is practically circular, and is reminiscent of a spot of grease on cloth.

Prof. Joly has pointed out that this alteration in the surrounding materials must be due to the radio-activity of the zircon. That radio-active materials are capable of producing such colorations has been known from the early days of radium. A glass bottle, in which a radium preparation has been kept, is stained a deep purple by long-continued action of radium.

It may, perhaps, be thought that this idea, though plausible, is no more than a guess. It is, however, much more than that. We know, from the investigations of Prof. Bragg and Mr. Kleeman, that the α-particles of radium, which constitute the most important feature of radio-active emission, are able to penetrate only a limited and definite distance into solid materials. They then lose their characteristic properties, if, indeed, they are not altogether stopped. This distance has been measured experimentally, and Prof. Joly has shown that the distance is just the same as the distance to which the alteration round the zircon crystals extends. Thus we have full quantitative confirmation of the theory which attributes it to radio-activity.

I will now pass from the discussion of a very minute phenomenon to the discussion of a large scale one. It will be familiar to many that, in the opinion of some, at least there is reason for changing the views which have been held for two generations concerning the earth's internal heat. We know that there is, at any rate, some radium in the earth, and that radium gives out heat. Thus it cannot be disputed that some part of the earth's internal heat must be due to this cause; the only question which remains is whether this part is large or small; whether, in fact, the earth's internal heat is chiefly to be accounted for as a small remnant of the much greater internal heat which it once possessed, or whether there is enough radio-active material in the earth to supply most of the annual loss by conduction through the crust and radiation into space.

As I mentioned before, I have made a large number of determinations of the quantity of radium in the rocks of which the superficial portions of the earth are constituted. These are found to be so rich in radium that the difficulty is not so much to account for the internal heat of the earth, as determined by underground observations of temperature, but rather to understand why it is not much hotter. I have suggested, as an explanation, that this general distribution of radio-active material, which pervades the outer parts of the earth, is in reality superficial, extending only to some moderate number of miles in depth, though no doubt much deeper than the deepest mines. I am not wholly satisfied, however, of the sufficiency of this explanation. Radium, and the series of products of which it is one, are not the only radio-active materials in the earth; there is another series, of which thorium is a member, and there is good reason to suppose that thorium is present in rocks in such quantity as to add appreciably to the evolution of heat. Taking this into account, we should probably find, if we had exact data for calculation, that the thickness of rock containing radio-active material was so small that the material of the interior would somewhere have exuded, in the course of the violent dislocations and earth movements which geology reveals to us. No material, however, appears anywhere at the earth's surface which can plausibly be regarded as representative of the unknown interior, if the suggested hypothesis is accepted. It cannot be denied that the subject is at present obscure. Possibly an explanation may be found by supposing that the activity of uranium may be arrested at high temperatures. We have at present no adequate experimental evidence on the subject. It is known that there is very little effect of this kind on radium. If, however, the activity of uranium were arrested at a high temperature, the supply of radium and all the other members of the series would fall off, and thus the aggregate heat production of the whole series might be greatly diminished.

I shall now pass to another branch of the subject. The investigations of Sir William Ramsay and Mr. Soddy have proved that there is continuous evolution of helium from the radium emanation. We have good reasons, into which, however, I do not propose to enter, for considering that the same is true of radio-active changes in general, at all events those in which there is an emission of radiation. Helium is probably evolved at each stage of the transformation of uranium, and at each stage of the transformation of thorium; and it results that the natural minerals and ores in which these elements are found, contain a store of helium, which has accumulated in them, and remains locked up in their pores.

As already mentioned, I have succeeded in determining the presence of radium in granite. Thus it becomes natural to inquire whether the corresponding amount of helium is to be found there too. Nothing of the kind had ever come under observation before, and it was therefore with some interest that I made the experiment. You see before you a vacuum tube of helium prepared from ordinary granite. The characteristic yellow glow will satisfy anyone acquainted with the appearance of a helium discharge of the presence of the gas.

The facility with which helium was detected in granite suggested further experimental problems. The undoubtedly radio-active elements are at present confined to uranium and thorium, and their respective families of descendants. Evidence has been produced, by myself, among others, which suggests that lead and some other elements possess a feeble radio-activity of their own. But this evidence is somewhat equivocal. It seemed highly desirable to attack the question in a new way, and the idea suggested itself of looking for helium in the naturally occurring ores of all the elements, common and rare. This had indeed been done, to some extent, from quite a different point of view, by Sir William Ramsay and his coadjutors, in their first investigations on helium; but their observations were directed to finding a practical source of the gas, and were not carried out with anything approaching the minuteness required for the present purpose.

The upshot has been to prove the presence of helium in almost every mineral examined, and even in such unpromising materials as rock crystal, or common quartz sand. The quantity found in the various cases has varied very widely. In fact, minerals may be found having any helium content, from thorianite,

*A discourse delivered at the Royal Institution.

which contains 10 cubic centimeters per gramme, down to rock crystal, which contains about a ten-millionth part of that quantity.

Are we to regard the helium in common minerals as due to a feeble radio-activity of the common elements? No doubt such a hypothesis is tempting, but it must be rejected. Radium is present everywhere in traces, and these traces are in general sufficient to account for the minute quantities of helium. This is illustrated in the table below, which gives in round numbers the actual amount of helium extracted from various minerals by heat, and the amount of helium reckoned relatively to the radium.

There is reason to think, as already mentioned, that the presence of thorium would constitute another source of helium. But it is believed that this complication does not produce any appreciable effect in these cases. Minerals like quartz, though they contain actually only an infinitesimal quantity of either substance, still show about the same proportion of helium to radium as the minerals which are rich in both. We may conclude that helium is connected with radium in the poor minerals as in the rich ones.

Mineral.	Helium present c.mm. per kil.	Helium ratio., i.e., ratio of helium to radium (arbitrary scale)
Normal—		
Samarskite	1,500,000	14
Hæmatite	700	9
Galena	2	17
Quartz	2	10
Abnormal—		
Beryl	33,000	954

I have, however, encountered an interesting exception to this rule in the mineral beryl. Beryl is, in all essentials, the same as emerald; the latter name is kept for stones which are of a clear deep green color, but scientifically the distinction is of no importance. Some beryls contain enormously more helium than can be accounted for by the small traces of radium in them. Nor do they contain any appreciable quantity of other radio-active material. What view, then, can we take of the presence of helium in this mineral? It is, to me at least, difficult to believe that the gas can have been introduced from without. If not, can it have been generated from radium formerly existing in the beryl, but now exhausted? This, too, seems unlikely, for it would imply that beryls are older than other minerals, and there is no plausibility in such a theory from the geological standpoint. My own opinion is that, in all probability, an element hitherto unknown exists in the mineral, from which the helium is generated. It may be objected that, in that case, the mineral ought to be radio-active. If, however, the radiation were emitted with less than the critical velocity, we should not be able to detect it, and nothing is known to make such an hypothesis improbable.

THE MERITS OF LIQUID FUEL*

A GENERAL REVIEW FOR PURPOSES OF COMPARISON.

BY CHARLES L. HUBBARD.

THE object of this article is to give a brief review of the subject rather than to take up in detail any particular branch or present the results of any single test: and is especially for those who wish for a general knowledge of the matter for purposes of comparison without going too much into the details. The data presented represent average rather than specific conditions and results.

Taking up briefly the advantages and disadvantages of liquid fuel as compared with coal, we may mention among the former absence of ashes and soot, cleaner heating surfaces, a more even distribution of heat in the combustion chamber, as it is not necessary to open the feed doors to supply fresh fuel, and an increased steaming capacity of the boilers due to the above conditions. It might be mentioned here, however, that the recent improvements in mechanical stokers tend to secure the above results in the case of coal also, but the greater simplicity of the apparatus required in oil burning, together with the absence of dust, ashes, and clinkers and the ease of handling, are still important factors in favor of oil.

The disadvantages include danger of explosion under certain conditions, noise from the burners if not properly designed and adjusted, and higher cost, except in or comparatively near to the sections where oil is produced.

The two kinds of oil in general use are the crude petroleum as it comes from the wells, and the residuum remaining after the lighter products have been removed by distillation. The combustion of one pound of petroleum will produce on an average from 17,000 to 20,000 heat units, as against 12,000 to 14,000 for the same weight of coal, thus making its heating value, pound for pound, about 50 per cent greater. Under the conditions of actual practice this difference is somewhat greater, and it is customary to consider 3½ to 4½ barrels of oil containing 42 gallons each, as equivalent to a ton of coal (2,000 pounds). With these data at hand as a basis, the relative costs of the two fuels can be easily approximated for any locality by making due allowance for the reduced cost of labor in the case of oil.

In burning oil, it must first be changed to a vapor, then mixed with air in the right proportion, and combustion must take place in a furnace in which a suitable temperature is maintained. The foundation of a method of oil burning depends upon: First, means for vaporizing the oil; second, an adequate supply of air delivered in such a manner as to be thoroughly mixed with the oil vapor in the right proportions, and third, provision for properly heating the oil and air either before mixing or immediately afterward as it is fed into the furnace. Although there are many forms of burners in common use, they may be divided into three general classes as follows: Mechanical spray burners, air burners, and steam-jet burners. In the first the oil is forced through a specially designed nozzle under a high pressure and is delivered to the furnace in the form of a fine spray which renders it easily inflammable. In the Körting burner the oil is passed at a temperature of about 270 deg. and a pressure of 50 pounds per square inch through a nozzle containing a specially grooved spindle; the effect of this is to give the oil a rotary motion, which breaks it into a spray as it leaves the nozzle. Another form of this type of burner causes the oil to pass through a small orifice against a cutter placed a short distance in front of it, the effect being similar in this case to the one already described.

In the air burners, so called, the oil is held in suspension and driven into the furnace by means of a jet of compressed air. Steam-jet burners act in a similar manner to those in which compressed air is used; the oil being injected in the form of a spray, a jet of steam being employed for this purpose instead of compressed air. Air in the right proportion is mixed with the oil and steam by means of an opening in the side of the burner and also by way of openings from the ash pit into the furnace. The use of compressed air and steam in a burner is much the same, but the air should first be heated to a high temperature by passing it through a fire-brick duct passing along the side of the furnace or of the combustion chamber.

In the Grundell-Tucker air burner, both the air and oil are supplied under a pressure of about 30 pounds per square inch. The oil is ordinarily heated by a steam coil to a temperature of 120 to 130 deg., and the air to about 350 deg. The high temperature of the latter is due in part to mechanical compression and partly to the absorption of heat while passing through the air chamber surrounding the burner.

The Williams burner is a representative of the steam-jet type. In this, the steam and oil are supplied through separate openings meeting at the end of a conical spindle placed at the center of the steam-delivery tube. Heated air is admitted through a third opening placed just beyond the spindle. Valves are provided for regulating the flow of steam, oil, and air, and the mixture is blown into the furnace in the right proportion for combustion. For securing the best results with burners of this type, steam at a high pressure is desirable. Steam-jet burners spread the flame more and are thus more desirable for large furnaces with much exposed brickwork.

With air burners the flame is more concentrated and therefore more destructive to the boiler plates and setting. The best number of burners depends upon the size of the boiler.

They are commonly made in various sizes up to 300 horse-power or more, but several burners of smaller size are found to be more economical in the use of oil than a single large one. Common practice calls for one burner for each 60 to 80 horse-power under ordinary conditions. Another way to determine the number of burners is to place one in the center of each fire door. The arrangement of the furnace and its general construction depends largely upon the make of boiler and type of burner to be employed. The usual method is to cover the grates with brickwork, keeping them and the furnace walls in a state of incandescence by spraying them with the burning oil. Broken fire brick are commonly used for covering the grates, being spread over them in the form of a porous bed for admitting an abundance of air for combustion. The grates should be of ample size and air may be admitted by way of the ash pit in the usual manner.

A bridgewall is provided in the same manner as for a coal-burning furnace. Sometimes the grates are plastered over with a layer of fire brick laid in plastic asbestos, and air admitted from below through special openings of 70 to 80 square inches for each 50-horse-power burner. Where this arrangement is used, a spatter wall, so called, built up of fire brick is placed in front of the bridgewall and the flame from the burners directed against it. In some cases special burners are attached directly to the grates without change.

Care should always be taken to keep the direct flame away from the plates, as they are liable to damage from burning. Various arrangements are used for the storage of oil, the most approved being an underground tank of plate steel or iron located outside of the boiler room.

The oil should be kept warm in order that it may flow more readily through the pipes leading to the burners. If a pump is used, a coil may be placed in the tank, through which exhaust steam may be passed. Sometimes the oil is forced to the burners by admitting steam or compressed air to the upper part of the storage tank. If the former is used, it serves also to warm the oil. Hot water from the boilers is also used for this purpose in some cases.

For the best results the pressure of oil at the burners should be kept constant. This may be done by first pumping it to a standpipe and allowing it to flow to the burners under a constant head due to its elevation, or it may be supplied directly by a pump provided with a relief valve and bypass so arranged that the pressure in the delivery pipe will remain constant. In case a standpipe is used, an automatic valve should be provided for draining it when the steam pressure drops below a given point in order to prevent flooding the burners when the pressure is not sufficient to atomize the oil.

Oil used for fuel is not of itself easily inflammable, but when heated much above 140 deg., gives off gases which, if mixed with air in the proper proportion, are highly explosive. For this reason the storage tank should be located well away from the boilers and the heat of the sun. Gases may also be formed if air is forced through the oil, or if it is violently agitated, as by passing it continuously through a pump where the discharge from a relief valve is connected directly into the suction pipe. When proper precautions are taken, there should be no danger from explosion, and the element of danger need not be seriously considered in a plant properly installed.

*Power and the Engineer.

An explanation of the shortened life of tantalum lamps on alternating circuits is given by Signor Scarpa in Elektrotechnik und Maschinenbau. He suggests that it is due to rapid mechanical vibration set up by electrodynamic action in the long straight parts of the filament. This gradually induces a crystalline state of the material, and numerous points of breakage occur in the filament. The writer made experiments with a microscope having a micrometer eyepiece, and sending first a direct current and then an alternating current through the lamp while under observation. The apparent thickness of the filament was double as great with the alternating as with the direct current, owing to the rapid vibration set up. At the same time the brightness of the filament appears greatest at the outer edges. The apparent thickness also varies periodically in accordance with the natural frequency of the filament. With vertically arranged U-shaped carbon filaments the vibrations could be noticed by eye. The writer is of opinion that in the osmium lamps the vibrations are considerably less than in the tantalum lamps, owing to the smaller weight and increased damping, and this explains the longer life of the former. In order to eliminate this effect of an alternating current as far as possible, the parts of the filament should be kept equidistant everywhere, so as to delay the crystallization.

TRAINING THE MAN BEHIND THE GUN.

HOW THE GUNNER IS TAUGHT TO HIT THE TARGET.

IN the British navy, when training men for efficiency in gun handling, a device is made use of that entirely does away with the wear and tear upon the breech mechanism of the actual guns that is always associated with loading drills. This is a model of the breech of a 6-inch cannon, and is constructed in such a manner that a gun's crew can perform all the actual operations necessary for firing in action. Any number of rounds can be theoretically discharged, and the men are taught to load with rapidity and are made familiar with the situation and manipulation of the various parts of the breech mechanism. them from the rifle barrel already mentioned. The bullets are caught in an iron box filled with oakum fixed to the muzzle of the gun. For practice with big guns, the cannon tube is made use of; it is an aiming rifle inserted in the bore of a big gun (the one in the illustration is a 7.5-inch with a one-inch tube). From this rifle are fired small projectiles weighing about half a pound. Practice is taken at targets towed by a launch. In the illustration, three small black targets are shown, and the gun-layer having been instructed to fire at the left-hand target, has just dropped a shot alongside it. The gunnery officer

THE "DREADNOUGHT" FIRING HER HEAVY 12-INCH GUNS AT A TARGET 7,000 YARDS OFF.

H. M. S. "DREADNOUGHT" FIRING HER 12-INCH GUNS. IN EIGHT MINUTES FORTY ROUNDS WERE FIRED, OF WHICH TWENTY-SIX WERE HITS.

Courtesy of Illustrated London News.

TRAINING THE MAN BEHIND THE GUN.

At the foot of the loader, shown in the illustration, may be seen the projectiles, weighing each 100 pounds, a dummy cylindrical charge representing 29 pounds of service powder, the rammer, and the belt containing the electric tubes by means of which the gun is fired.

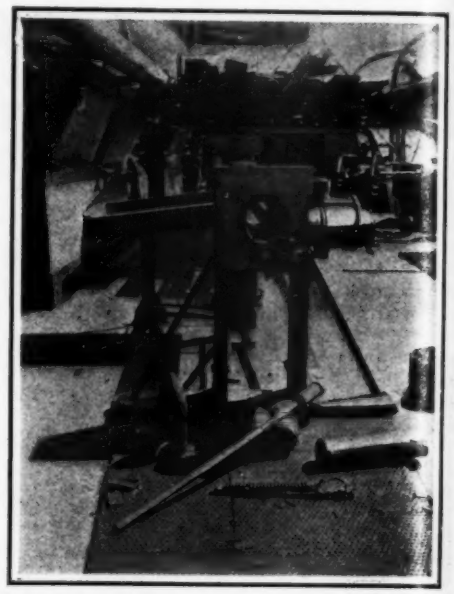
The deflection teacher is another arrangement that greatly increases the expertness of gun-layers at a very slight expense. A rifle barrel is fixed on the gun near the breech, and is so arranged that it is fired by pressing the trigger of the gun itself. A long iron spar is pivoted above the gun just inside of the casemate, and can be moved about laterally. This, when operated by means of the proper ropes or guys, represents a ship steaming past. A wooden frame at the end of the spar holds a sheet of cardboard upon which are painted small targets; then, while the spar is being moved about, the gun-layer inside the casemate tries to keep his gun trained on the targets. When satisfied with his aim, he fires at sitting on the top of the turret takes note, and prizes are awarded to the best shots. These prizes allowed to each ship for good shooting by the Admiralty are very generous; for example, a ship having a complement of 636, receives $265 per year.

The targets used measure 20 by 15 feet, and for individual ship practice are the miniature of those used at the annual battle practice recently completed by the ships of the Atlantic fleet. The range-finding instruments, worked by an officer in telephonic communication with all the guns in the ship, are situated in the fighting top, half way up the mast.

The railway which is to join Shanghai with Hangchow and Ningpo was opened as far as Sunkiang, a distance of 24 miles, on the 20th April last for passenger and freight traffic. The whole scheme down to the minutest detail has been carried out by Chinese. The whole of the permanent way and much of the rolling stock was also supplied from Chinese sources. Bridging and permanent way are said to be thoroughly sound. There is every probability of the line proving a highly successful enterprise, as the district through which the railway runs is one of great agricultural wealth.

THE MONSTER BATTLESHIP CONTROVERSY.

THAT the advent of the "Dreadnought" type of warship, with its greater speed and larger number of guns of maximum caliber, has profoundly altered the aspect of naval construction is generally admitted,



THE LOADER.

FIRING WITH CANNON TUBE AT MOVING TARGET.

but the opinion of those most qualified by training and experience to judge the merits of the change is by no means unanimous. It is alleged by the opponents of the change either that the "Dreadnought" is not superior to the battleships immediately preceding her, or else, granting a slight superiority, it has been purchased at too great a cost. There is a third view that the increase of size and cost was not justified by the naval situation generally or the teaching of experience; and that though it might be necessary at some future time to increase displacement in reply to the efforts of foreign powers the step was not immediately necessary. In the arrangement of the details of a design great variation is possible, and different naval architects will adopt different dispositions, according to their individuality and previous experience; but in the matter of size no such diversity can exist when the main features of armor, armament, speed, and coal capacity have been fixed. Each of these involves a certain weight; they also necessarily involve a more

or less definite weight of hull in which to carry them, and a strictly proportional weight of equipment. When all these have been added together a minimum displacement on which these qualities can be obtained is arrived at, and to attempt to solve the problem on less than this minimum is as fruitless as the endeavor to compass the solution of the time-honored problem concerning a quart and a pint pot. There are, of course, expedients which, as we pointed out in the consideration of the American naval report, can be adopted with a view of keeping down the displacement, but their use will result in the production of a design much better on paper than in the realization, and they must be ruled out in any dispassionate comparison of types. Seeing that the offensive and defensive qualities of a ship are so directly connected with displacement, it follows that in comparing two designs, and granting the weights have been equally economically used in each case, the larger ship must in some or all these qualities be superior to the smaller.

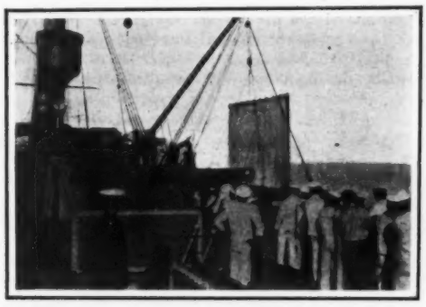
In order to sustain the first objection to the "Dreadnought" type to which we referred, it is therefore necessary to show that the weights have not been used as economically as in the previous types. Sir William White, in his able article in the Nineteenth Century, while carefully stating that nothing which he has written should be taken as a criticism of the work of his successor in office, attacks the all-big-gun ship in general and the "Dreadnought" in particular; and in view of his disclaimer it would appear that the conclusion which he desires to be drawn from his article is that it is impossible to produce a satisfactory design involving the all-big-gun principle.

Sir William White points out that where heavy guns are carried at a great height above water, as they are in the "Dreadnought," the center of gravity is raised; but figures will show whether the weight of the armament is greater in the case of the "Dreadnought" in proportion to the displacement than in the "King Edward." We should imagine the percentage which this item is of the total is not sensibly different in the two cases. There is the further consideration that the adoption of turbines has involved a considerable reduction in the vertical position of the center of gravity of machinery, and this will assist the architect in either of three ways—enable a greater weight to be carried in a given position; or the same weight in a higher position, in neither case keeping the stability constant; or the same weight in the same position with an increase of stability. In Sir William White's battleships the metacentric height was, we remember, kept at about 3½ feet, and we believe the figure for the "Dreadnought" is not less, while it may be taken for granted that the customary calculations of the stability with various compartments bilged were carried out in the usual complete and exhaustive manner, and that provision was made for stability in a damaged condition to the same extent as has previously been the practice. While, therefore, the adoption of the all-big-gun design is fairly open to debate from military considerations, it does not appear that the contention can be sustained that a satisfactory design with this feature is impossible.

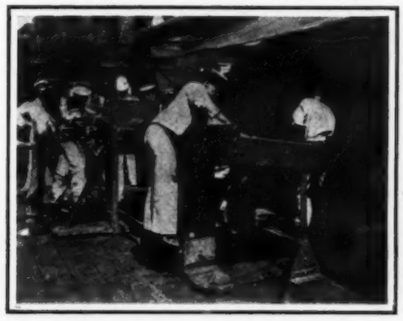
With regard to the second objection to the "Dreadnought" type, it must be admitted that the increase of the qualities of offense and defense must result in a greater proportionate increase of size and cost, and in no case is this so noticeable as in the matter of speed. On the same displacement, the power, and therefore the weight and cost of machinery, will go up as the cube of the speed; but as an increase of machinery weight must inevitably be accompanied by an addition to weight of hull, the increase of cost of machinery, keeping the other qualities of the ship constant, must go up at a greater rate than the cube of the speed. In the case of the "Dreadnought" the increase has been minimized by the adoption of turbines, which, on account of their superior economy at full speed, have required, it is claimed, only 85 per cent of the boiler power which would have been necessary with reciprocating engines. In a similar way, if armor or armament, or both, are increased, weight of hull to carry them must be increased, and more engine power must be provided if the speed is to be kept constant. The essential qualities of a ship as a fighting machine being thus so intimately related, the effect of an increase in one or more of them on the displacement is cumulative, and it must follow that less offensive and defensive power per ton of displacement can be obtained as the size is increased. In applying this general principle, however, due regard must be had to the successive improvements in material and in the design and economy of the propelling apparatus, which may from time to time make improvement in fighting qualities possible without additional displacement.

The second objection to the "Dreadnought" type, that the increase in size and cost is not commensurate with the gain in fighting qualities, must of necessity be true, but it ceases to have any weight if it can be shown that the enhanced qualities, whatever their magnitude, are necessary for the maintenance of our naval position. In the matter of number and caliber of guns the opinion of experts will be sure to differ, and had the "Dreadnought" been fitted with four 12-inch and twelve 9.2-inch, or four 12-inch and twenty 6-inch instead of ten 12-inch, the criticism of increased size and cost would have still been made.

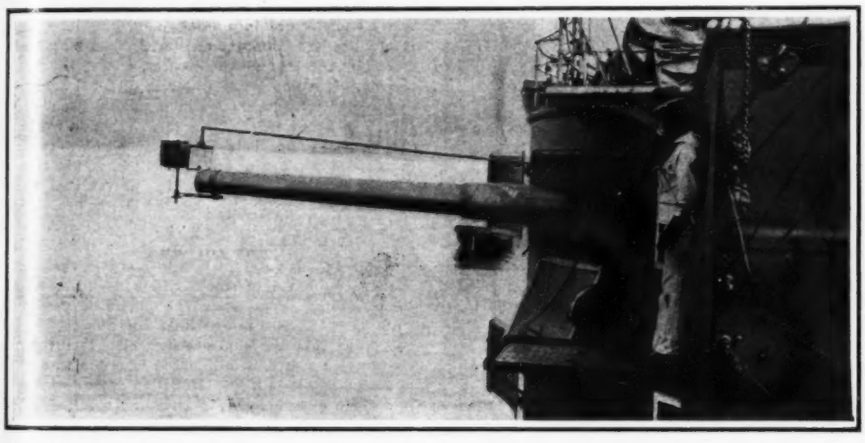
The third objection, that the increase in size and cost was not justified by the naval situation generally or the teaching of experience, deserves much more respect than the others, and appears to have considerable force. Unfortunately, or fortunately, from whichever point of view we look at it, there has been no important naval engagement in which modern ships have been involved with the single exception of the battle of Tsushima on May 27, 1905. The previous battle in the Russo-Japanese war on August 10, 1904, when the Port Arthur fleet tried to escape, was a relatively unimportant affair. The advocates of the monster battleship claim that the lessons of Tsushima support their case; but whether this be so or not, it is quite certain that the incidents of it could have had no direct bearing on the "Dreadnought" design. The Admiralty committee of design had completed its labors when Tsushima was fought, and the design must have been at that date in an advanced state, as this vessel was laid down a few months later. It is further known that owing to Japanese reserve reliable details were difficult to obtain, and did not begin to filter through for a long time after. The lessons of this fight are not so definite as they might have been, as the Russians were so absolutely outclassed in gunnery, and the Japanese triumph was rather one of personnel and training than of material. So far as can be gathered from Capt. Semenoff's account, the superior speed of the Japanese was not of noticeable tactical advantage. The speed of the Russian fleet is given at 10 knots, that of the Japanese at 15, but in spite of this superiority Admiral Togo did not succeed in his endeavor to cross the T of the Russian line, and the action was practically a broadside one throughout, the two fleets steaming roughly in concentric circles, the outer one having a radius of about five miles. The greater the range, the greater the advantage in speed required by the outside fleet; in fact, at the ranges at which it is generally conceded future actions will be fought, the superiority in speed required will be so great that it is questionable whether it is worth while attempting. It does not appear that had Admiral Togo had the "Dreadnought's" speed he would have been able to make much, if any, better use of it than he did of 15 knots. The damage to the Russian ships appears principally to have been caused by shell fire, and, as Sir William White points out, they were sunk mostly by penetration of the lightly protected ends. The "Oslabia" was sunk about an hour after the commencement of the fight by three consecutive shells striking just



HOISTING OUT A TARGET FOR GUN PRACTICE.

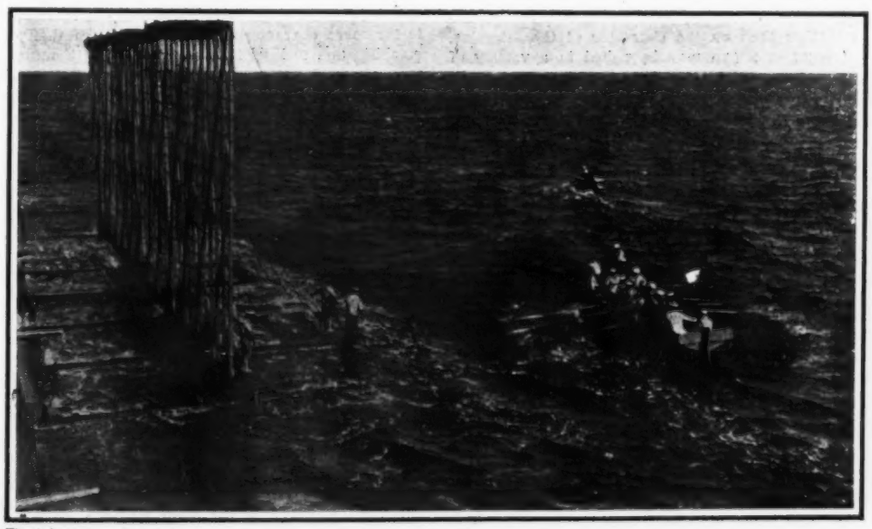


A GUN'S CREW PRACTISING WITH THE LOADER.



The Sphere.

DEFLECTION TEACHER.



The Sphere.

SECURING THE TARGET TO FIXED BUOYS.

TRAINING THE MAN BEHIND THE GUN.

above the waterline before the fore turret, making not a hole, but a "regular gateway." This lesson is one of the strongest arguments against increase of displacement. It is only necessary for our present purpose to refer to one other detail of this fight. The Japanese 12-inch guns did not make such good shooting as they might have done, as the bores were worn, and the shells could be seen turning somersaults in the air. It is well known that the effective life of a gun is smaller the greater the bore, and the effect of this when warlike operations are extended over a considerable period may be of vital importance, and it provides a strong argument for a return to the mixed armament. The Japanese appear, at any rate, not to be committed at present to the all-big-gun principle. The question, however, of all-big-gun or mixed armament has very little bearing on displacement; the former will have a greater weight of shell per broadside, but the latter will make up by rapidity of fire, and practically on a given displacement the weight discharged in one minute will be the same in each case.

We may leave this to the experts, but while it may be a matter for regret that the recent large increases in displacement have been made, the situation as it now is must be faced. We have made the pace in size, and other nations are following as fast as their dockyards can build, and it is now impossible to go back. The situation of this country is peculiar, in that to us numbers of ships are essential, and it appears particularly unfortunate that at a time when the tendency is for the national revenue to be diverted into new sources of expenditure, the cost of the individual ship has been so largely increased, thus making the provision of the necessary number of ships difficult. The matter is not one so much of design as of finance, and it is the duty of responsible ministers to see that the necessary funds are forthcoming in order that we may maintain our position.—The Engineer.

THE MOVEMENTS OF PLANTS.—I.*

IS GROWTH THE RESULT OF MEMORY?

BY FRANCIS DARWIN, M.A., PH.D., LL.D., F.R.S.

In his book on "The Power of Movement in Plants" (1880) my father wrote that "it is impossible not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals." In the previous year Sachs had in like manner called attention to the essential resemblance between the irritability of plants and animals. I give these statements first because of their simplicity and directness; but it must not be forgotten that before this Pfeffer had begun to lay down the principles of what is now known as *Reizphysiologie*, or the physiology of stimulus, for which he and his pupils have done so much. The words of Darwin which I have quoted afford an example of the way in which science returns to the obvious. Here we find revived, in a rational form, the point of view of the child or of the writer of fairy stories. We do not go so far as the child: we know that flowers do not talk or walk; but the fact that plants must be classed with animals as regards their manner of reaction to stimuli has now become almost a commonplace of physiology, and, inasmuch as we ourselves are animals, this conception gives us a certain insight into the reactions of plants which we should not otherwise possess. This is, I allow, a very dangerous tendency, leading to anthropomorphism—one of the seven deadly sins of science. Nevertheless, it is one that must be used unless the great mass of knowledge accumulated by psychologists is to be forbidden ground to the physiologist. Jennings has admirably expressed the point of view from which we ought to deal with the behavior of the simpler organisms. He points out that we must study their movements in a strictly objective manner—that the same point of view must be applied to man, and that any resemblances between the two sets of phenomena are not only an allowable, but a necessary, aid to research. What, then, are the essential characters of stimuli and of the reactions which they call forth in living organisms? Pfeffer has stated this in the most objective way. An organism is a machine which can be set going by touching a spring or trigger of some kind—a machine in which energy can be set free by some kind of releasing mechanism. Here we have a model of at least some of the features of reaction to stimulation. The energy of the cause is generally out of all proportion to the effect—i. e., a small stimulus produces a big reaction. The specific character of the result depends on the structure of the machine rather than on the character of the stimulus. The trigger of a gun may be pulled in a variety of different ways without affecting the character of the explosion. Just in the same way, a plant may be made to curve by altering its angle to the vertical, by lateral illumination, by chemical agency, and so forth. The curvature is of the same nature in all cases; the release action differs. One of those chains of wooden bricks in which each knocks over the next may be set in action by a touch, by throwing a ball, by an erring dog—in short, by anything that upsets the equilibrium of brick No. 1; but the really important part of the game, the way in which the wave of falling bricks passes like a prairie fire round a group of Noah's Ark animals, or by a bridge over its own dead body, and returns to the starting-point, etc.—these are the result of the magnificent structure of the thing as a whole, and the upset of brick No. 1 seems a small thing in comparison. For myself, I see no reason why the term "stimulus" should not be used in relation to the action of mechanisms in general; but, by a convention which it is well to respect, "stimulation" is confined to the protoplasmic machinery of living organisms. The want of proportion between the stimulus and the reply, or, as it has been expressed, the unexpectedness of the result of a given stimulus, is a striking feature in the phenomena of reaction. That this should be so need not surprise us. We can, as a rule, know only the stimulus and the response, while the intermediate processes of the mechanism are hidden in the secret life of protoplasm. We might, however, have guessed that big changes would result from small stimuli, since it is clear that the success of an organism in the world must depend, partly at least, on its being highly sensitive to changes in its surroundings. This is the adaptive side of the fundamental fact that living protoplasm is a highly unstable body. Here I may say one word about the adaptation as treated in the "Origin of Species." It is the present fashion to minimize or deny altogether the importance of natural selection. I do not propose to enter into this subject: I am convinced that the inherent strength of the doctrine will insure its final victory over the present anti-Darwinian stream of criticism. From the Darwinian point of view, it would be a remarkable fact if the reactions of organisms to natural stimuli were not adaptive. That they should be so, as they undoubtedly are, is not surprising. But just now I call attention only to the adaptive character of reactions from a descriptive point of view. Hitherto I have implied the existence of a general character in stimulation without actually naming it—I mean the indirectness of the result. This is the point of view of Dutrochet, who in 1824 said that the environment suggests, but does not directly cause, the reaction. It is not easy to make clear in a few words the conception of indirectness. Pfeffer employs the word "induction," and holds that external stimuli act by producing internal change, such changes being the link between stimulus and reaction. It may seem, at first sight, that we do not gain much by this supposition; but, since these changes may be more or less enduring, we gain at least the conception of *after-effect* as a quality of stimulation. What are known as *spontaneous* actions must be considered as due to internal changes of unknown origin. It may be said that in speaking of the "indirectness" of the response to stimuli we are merely expressing in other words the conception of release-action—that the explosion of a machine is an indirect reply to the touch on the trigger. This is doubtless true; but we possibly lose something if we attempt to compress the whole problem into the truism that the organism behaves as it does because it has a certain structure. The quality of indirectness is far more characteristic of an organism than of a machine, and to keep it in mind is more illuminating than a slavish adherence to the analogy of a machine. The reaction of an organism depends on its past history; but, it may be answered, this is also true of a machine the action of which depends on how it was made, and, in a less degree, on the treatment it has received during use. But in living things this last feature in behavior is far more striking, and in the higher organisms past experience is all-important in deciding the response to stimulus. The organism is a plastic machine, profoundly affected in structure by its own action, and the unknown process intervening between stimulus and reaction (on which the indirectness of the response depends) must have the fullest value allowed it as a characteristic of living creatures.

For the zoological side of biology, a view similar to that of Pfeffer has been clearly stated by Jennings in his admirable studies on the behavior of infusoria, rotifers, etc. He advances strong arguments against the theories of Loeb and others, according to which the stimulus acts directly on the organs of movement—a point of view which was formerly held by botanists, but has since given place to the conception of the stimulation acting on the organism as a whole. Unfortunately for botanists, these movements are by the zoologists called *tropisms*, and are thus liable to be confused with the geotropism, heliotropism, etc., of plants. To these movements, which are not considered by botanists to be due to direct action of stimuli, Loeb's assumptions do not seem to be applicable. Jennings's position is that we must take into consideration what he calls "physiological state—i. e., 'the varying internal physiological conditions of the organism as distinguished from permanent anatomical conditions.'" Though he does not claim novelty for his view, I am not aware that it has ever been so well stated. External stimuli are supposed to act by altering this physiological state—that is, the organism is temporarily transformed into what, judged by its reactions, is practically a different creature. This may be illustrated by the behavior of *Stentor*, one of the fixed infusoria. If a fine jet of water is directed against the disk of the creature, it contracts "like a flash" into its tube. In about half a minute it expands again, and the cilia resume their activity. Now we cause the current to act again upon the disk. This time the *Stentor* does not contract, which proves that the animal has been in some way changed by the first stimulus. This is a simple example of "physiological state." When the *Stentor* was at rest, before it received the first current of water, it was in state 1; the stimulus changed state 1 into state 2, to which contraction is the reaction; when again stimulated it passed into state 3, which does not produce contraction. We cannot prove that the contraction which occurred when the *Stentor* was first stimulated was due to a change of state; but it is a fair deduction from the result of the whole experiment, for after the original reaction the creature is undoubtedly in a changed state, since it no longer reacts in the same way as to a repetition of the original stimulus. Jennings points out that, as in the case of plants, spontaneous acts are brought about when the physiological state is changed by unknown causes, whereas in other cases we can point to an external agency by which the same result is effected.

MORPHOLOGICAL CHANGES.

Let us pass on to the consideration of the permanent or morphological changes and the stimuli by which they are produced—a subject to which, in recent years, many workers have devoted themselves. I need only mention the names of Vöchting, Goebel, and Klebs among botanists, and those of Loeb, Herbst, and Driesch among zoologists, to remind you of the type of research to which I refer. These morphological alterations produced by changes in environment have been brought under the rubric of reaction to stimulation, and must be considered as essentially similar to the class of temporary movements of which I have spoken. The very first stage in development may be determined by a purely external stimulus. Thus the position of the first cell-wall in the developing spore of *Equisetum* is determined by the direction of incident light. In the same way, the direction of light settles the plane of symmetry of *Marchantia* as it develops from the gemma. But the more interesting cases are those where the presence or absence of a stimulus makes an elaborate structural difference in the organism. Thus, as Stahl has shown, beech leaves developed in the deep shade of the middle of the tree are so different in structure from leaves grown in full sunlight that they would unhesitatingly be described as belonging to different species. Another well-known case is the development of the scale-leaves on the rhizome of *Circæa* into the foliage leaves under the action of light. The power which the experimenter has over the lower plants is shown by Klebs, who kept *Saprolegnia mixta*, a fungus found on dead flies, in uninterrupted vegetative growth for six years; while by removing a fragment of the plant and cultivating it in other conditions the reproductive organs could at any time be made to appear. *Chlamydomonas media*, a unicellular green alga, when grown in a 0.4 per cent

* Presidential address before the British Association for the Advancement of Science at Dublin.

nutrient solution continues to increase by simple division, but conjugating gametes are formed in a few days if the plant is placed in pure water and kept in bright light. Numberless other cases could be given of the regulation of form in the lower organisms. Thus *Sporodinia* grown on peptone-gelatine produces sporangiferous hypha, but on sugar zygotes are formed. Again, *Protosiphon botryoides*, if grown on damp clay, can most readily be made to produce spores by transference to water either in light or in darkness. But for the same plant cultivated in Knop's solution the end can best be obtained by placing the culture in the dark. Still these instances of the regulation of reproduction are not so interesting from our point of view as some of Klebs's later results. Thus he has shown that the color of the flower of *Campanula trachelium* can be changed from blue to white and back again to blue by varying the conditions under which the plant is cultivated. Again, with *Sempervivum* he has been able to produce striking results—e. g., the formation of apetalous flowers with one instead of two rows of stamens. Diminution in the number of stamens is a common occurrence in his experimental plants, and absolute loss of these organs also occurs. Many other abnormalities were induced, both in the stamens and in other parts of the flowers. There is nothing new in the character of these facts; what has been brought to light (principally by the work of Klebs) is the degree to which ontogeny is controllable. We are so much in the habit of thinking of the stable element in ontogeny that the work of Klebs strikes us with something of a shock. Most people would allow that change of form is ultimately referable to changed conditions, but many of us were not prepared to learn the great importance of external stimuli in ontogeny. Klebs begins by assuming that every species has a definite *specific structure*, which he compares to chemical character. Just as a substance such as sulphur may assume different forms under different treatment, so he assumes that the specific structure of a plant has certain potentialities which may be brought to light by appropriate stimuli. He divides the agencies affecting the structure into external and internal conditions, the external being supposed to act by causing alterations in the internal conditions. It will be seen that the scheme is broadly the same as that of Pfeffer for the case of the movement and other temporary reactions. The internal conditions of Klebs correspond also to the "physiological state" of Jennings. From what has gone before, it will be seen that the current conception of stimulus is practically identical whether we look at the phenomena of movement or those of structure. If this is allowable—and the weight of evidence is strongly in its favor—a conclusion of some interest follows. If we reconsider what I have called the indirectness of stimulation, we shall see that it has a wider bearing than is at first obvious. The "internal condition" or "physiological state" is a factor in the regulation of the organism's action, and it is a factor which owes its character to external agencies which may no longer exist. The fact that stimuli are not momentary in effect but leave a trace of themselves on the organism is in fact the physical basis of the phenomena grouped under memory in its widest sense as indicating that action is regulated by past experience. Jennings remarks: "In the higher animals, and especially in man, the essential features in behavior depend very largely on the history of the individual; in other words, upon the present physiological condition of the individual, as determined by the stimuli it has received and the reactions it has performed. But in this respect the higher animals do not differ in principle, but only in degree, from the lower organisms. . . ." I venture to believe that this is true of plants as well as of animals, and that it is further broadly true not only of physiological behavior, but of the changes that are classed as morphological. Semon in his interesting book, "Die Mneme," has used the word *Engram* for the trace or record of a stimulus left on the organism. In this sense we may say that the internal conditions of Pfeffer, the physiological states of Jennings, and the internal conditions of Klebs are, broadly speaking, *Engrams*. The authors of these theories may perhaps object to this sweeping statement, but I venture to think it is broadly true. The fact that in some cases we recognize the chemical or physical character of the internal conditions does not by any means prevent our ascribing a *mnemic* memory-like character to them, since they remain causal agencies built up by external conditions which have, or may have, ceased to exist. Memory will be none the less memory when we know something of the chemistry and physics of its neural concomitant.

HABIT ILLUSTRATED BY MOVEMENT.

In order to make my meaning plain as to the existence of a *mnemic* factor in the life of plants, I shall for the moment leave the morphological side of life and give an instance of habitual movement. Sleeping plants are those in which the leaves assume at night a position markedly different from that shown by day. Thus the leaflets of the scarlet-runner (*Phaseolus*) are more or less horizontal by day and sink down at night. This change of position is known to be produced by the alternation of day and night. But this statement by no means exhausts the interest of the phenomenon. A sensitive photographic plate behaves differently in light and darkness; and so does a radiometer, which spins by day and rests at night. If a sleeping-plant is placed in a dark room after it has gone to sleep at night, it will be found next morning in the light position, and will again assume the nocturnal position as evening comes on. We have, in fact, what seems to be a habit built by the alternation of day and night. The plant normally drops its leaves at the stimulus of darkness and raises them at the stimulus of light. But here we see the leaves rising and falling in the absence of the accustomed stimulation. Since this change of position is not due to external conditions it must be the result of the internal conditions which habitually accompany the movement. This is the characteristic *par excellence* of habit—namely, a capacity, acquired by repetition, of reacting to a fraction of the original environment. We may express it in simpler language. When a series of actions are compelled to follow each other by applying a series of stimuli they become organically tied together, or *associated*, and follow each other automatically, even when the whole series of stimuli are not acting. Thus in the formation of habit *post hoc* comes to be equivalent to *propter hoc*. Action B automatically follows action A, because it has repeatedly been compelled to follow it. This may be compared with Herbert Spencer's description of an imaginary case, that of a simple aquatic animal which contracts its tentacles on their being touched by a fish or a bit of seaweed washed against it. If such a creature is also sensitive to light the circumstances under which contraction takes place will be made up of two stimuli—those of light and of contact—following each other in rapid succession. And, according to the above statement of the essential character of associative habit, it will result that the light-stimulus alone may suffice, and the animal will contract without being touched. Jennings has shown that the basis of memory by association exists in so low an organism as the infusorian *Stentor*. When the animal is stimulated by a jet of water containing carmine in suspension, a physiological state A is produced, which, however, does not immediately lead to a visible reaction. As the carmine stimulus is continued or repeated, state B is produced, to which the *Stentor* reacts by bending to one side. After several repetitions of the stimulus, state C is produced, to which the animal responds by reversing its ciliary movement, and C finally passes into D, which results in the *Stentor* contracting into its tube. The important thing is that after many repetitions of the above treatment the organism "contracts at once as soon as the carmine comes in contact with it." In other words, states B and C are apparently omitted, and A passes directly into D, i. e., into the state which gives contraction as a reaction. Thus we have in an infusorian a case of short-circuiting precisely like the case which has been quoted from Herbert Spencer as illustrating association. But Jennings's case has the advantage of being based on actual observation. He generalizes the result as the "law of the resolution of physiological states" in the following words: "The resolution of one physiological state into another becomes easier and more rapid after it has taken place a number of times." He goes on to point out that the operation of this law is seen in the higher organisms, "in the phenomena which we commonly call memory, association, habit formation, and learning." In spite of this evidence of mnemic power in the simplest of organisms, objections will no doubt be made to the statement that association of engrams can occur in plants. Pfeffer, whose authority none can question, accounts for the behavior of sleeping plants principally on the more general ground that when any movement occurs in a plant there is a tendency for it to be followed by a reversal—a swing of the physiological pendulum in the other direction. Pfeffer compares it to a released spring which makes several alternate movements before it settles down to equilibrium. But the fact that the return movements occur at the same time-intervals as the stimuli is obviously the striking feature of the case. If the pendulum-like swing always tended to occur naturally in a twelve hours' rhythm it would be a different matter. But Pfeffer has shown that a rhythm of six hours can equally well be built up. And the experiments of Miss Pertz and myself show that a half-hourly or quarter-hourly rhythm can be produced by alternate geotropic stimulation. We are indebted to Keeble for an interesting case of apparent habit among the lower animals. *Convoluta roscoffensis*, a minute, worm-like creature found on the coast of Brittany, leads a life dependent on the ebb and flow of the sea. When the tide is out the *Convoluta* come to the surface, showing themselves in large green patches. As the rising tide begins to cover them they sink down into safer quarters. The remarkable fact is that when kept in an aquarium, and therefore removed from tidal action, they continue for a short time to perform rhythmic movements in time with the tide. Let us take a human habit, for instance that of a man who goes a walk every day and turns back at a given mile-post. This becomes habitual, so that he reverses his walk automatically when the limit is reached. It is no explanation of the fact that the stimulus which makes him start from home includes his return—that he has a mental return-ticket. Such explanation does not account for the point at which he turns, which as a matter of fact is the result of association. In the same way a man who goes to sleep will ultimately wake; but the fact that he wakes at four in the morning depends on a habit built up by his being compelled to rise daily at that time. Even those who will deny that anything like association can occur in plants cannot deny that in the continuance of the nyctitropic rhythm in constant conditions we have, in plants, something which has general character of habit, i. e., a rhythmic action depending on a rhythmic stimulus that has ceased to exist. On the other hand, many will object that even the simplest form of association implies a nervous system. With regard to this objection it must be remembered that plants have two at least of the qualities characteristic of animals—namely, extreme sensitiveness to certain agencies and the power of transmitting stimuli from one part to another of the plant body. It is true that there is no central nervous system, nothing but a complex system of nuclei; but these have some of the qualities of nerve cells, while intercommunicating protoplasmic threads may play the part of nerves. Spencer bases the power of association on the fact that every discharge conveyed by a nerve "leaves it in a state for conveying a subsequent like discharge with less resistance." Is it not possible that the same thing may be as true of plants as it apparently is of infusoria? We have seen reasons to suppose that the "internal conditions" or "physiological states" in plants are of the nature of engrams, or residual effects of external stimuli, and such engrams may become associated in the same way. There is likely to be another objection to my assumption that a simple form of associated action occurs in plants—namely, that association implies consciousness. It is impossible to know whether or not plants are conscious; but it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves. I am told by psychologists that I must define my point of view. I am accused of occupying that unscientific position known as "sitting on the fence." It is said that, like other biologists, I try to pick out what suits my purpose from two opposite schools of thought—the psychological and the physiological! What I claim is that, as regards reaction to environment, a plant and a man must be placed in the same great class, in spite of the obvious fact that as regards complexity of behavior the difference between them is enormous. I am not a psychologist, and I am not bound to give an opinion as to how far the occurrence of definite actions in response to stimulus is a physiological and how far a psychological problem. I am told that I have no right to assume the neural series of changes to be the cause of the psychological series, though I am allowed to say that neural changes are the universal concomitants of psychological change. This seems to me, in my ignorance, an unsatisfactory position. I find myself obliged to believe that the mnemic quality in all living things (which is proved to exist by direct experiment) must depend on the physical changes in protoplasm, and that it is therefore permissible to use these changes as a notation in which the phenomena of habit may be expressed.

(To be continued.)

FEVER IN PLANTS.

ANIMALS and plants form two diverging branches of the tree of life and their vital phenomena are essentially identical. Both inhale oxygen and exhale carbon dioxide produced by the oxidation of carbonaceous matter. In plants, however, a process of deoxidation also takes place, the carbon dioxide of the atmosphere being resolved, with the aid of sunshine and chlorophyl, into carbon, which is used in the formation of organic compounds, and oxygen, of which the greater part is exhaled and a small portion is consumed in the process of oxidation mentioned above.

Plants appear to possess organs of sense and at least as much "mind" as the lowest animal organisms. They sleep, are narcotized by chloroform and ether, and are subject to many infectious diseases. Finally, plants are subject to fever, in which, however, the elevation of temperature is usually so slight that it can be detected only by the most delicate methods of investigation.

The body temperature of marine turtles is nearly 2 deg. F., and that of the tunny, a large fish protected by a thick layer of fat, is from 7 to 18 deg. F. higher than that of the surrounding water, but small fishes and most "cold blooded" animals have a temperature so near that of their environment that the difference cannot be detected. In most plants, likewise, the vital processes are not sufficiently active to maintain a temperature measurably higher than that of the air, but there are some notable exceptions to this rule. In

winter the trunks of trees are warm enough to melt the snow around them, and early in spring the Alpine soldenella pushes its delicate flower buds through the snow, which is melted by the heat developed in the process of respiration and oxidation which is going on in the buds. Respiration and oxidation are especially active in sprouting seeds, as is proved by the great quantity of heat evolved in malting vats in breweries. These processes are equally active in opening flower buds. The flowers of the blue bell, gentian, and aconite are from 3 to 7 deg. F., those of the South American *Victoria regia* 18 to 25 deg. F., and those of the arum 23 to 45 deg. F. warmer than the surrounding air. This evolution of heat, however, is greatest in hot climates, attaining a maximum at an external temperature of 75 to 85 deg. F.

In plants, as in animals, wounds bleed, heal, and leave scars, and in the conflict with invading microbes the metabolism may become so active as to cause fever, at first local and then more or less general. American botanists have recently discovered, with the aid of a thermo-electrical apparatus sensitive to 1/10 deg. F., that cutting a potato causes a local rise of temperature that attains a maximum in 24 hours and thereafter gradually subsides. A wounded onion develops a still higher fever, which is not, as in the potato, confined to the vicinity of the wound, but extends throughout the bulb. The complete results of these experiments, which have only been commenced, will be awaited with eager interest.—Prometheus.

THE IMPROVED PARSEVAL AIRSHIP

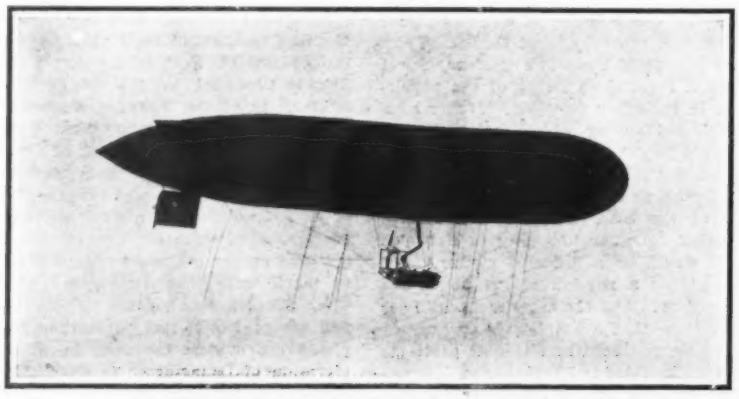
GERMANY'S NON-RIGID MILITARY DIRIGIBLE.

THE Parseval airship is of the non-rigid type, in which the requisite degree of rigidity is obtained by the pressure of ballonets, or auxiliary bags, filled with compressed air. The rigid parts have been made as few and as small as possible, in order to facilitate transportation. The new Parseval airship is 190 feet long and 30½ feet in diameter. Its cubic capacity is about 113,000 cubic feet, and its lifting power exceeds 3½ tons. The envelope is made of two thicknesses of cotton cloth with an inside coating of India rubber. There are two ballonets, one at each end, and the valves are so arranged that the pressure in either ballonet can be increased independently of the other, during flight, thus depressing the bow or stern by the weight of the added air. The airship being thus thrown into an inclined position acts as a kite and can be moved and maintained several hundred feet above or below its level of equilibrium, without sacrificing ballast or gas. The air pumps can be operated either by the motor or by hand. The form of the old Parseval airship was a cylinder with hemispherical ends, but the new vessel is shaped like a fish, having its greatest diameter near the bow. The experiments of Prof. Prandtl have proved that this form gives a minimum air resistance, and it is supposed to give greater stability as well.

The new airship has a Daimler motor of 100 horsepower. The propeller is made of envelope material mounted on aluminium frames. The peculiar feature of this propeller is its flexibility when at rest. In motion it stiffens under the influence of centrifugal force. Along the sides of the vessel extend steadying keels, composed of wooden frames supporting flat air bags, which have openings in front and are filled automatically during flight. One hundred gallons of gasoline suffice for a flight of ten hours.

The car is suspended by cords and pulleys in such a manner that it remains horizontal, even when the body of the airship is inclined. The propeller, which has four blades and a diameter of 11½ feet, is placed over the car. The combined weight of car, motor, water for cooling, and 137 gallons of gasoline is 2,860 pounds.

Still more important than the change in the suspension of the car is the improvement in the motor. A German society for the improvement of airships (Motor-Luftschiff-Studien-Gesellschaft) offered for the year 1908 two prizes, for motors for airships of 113,000 and 159,000 cubic feet capacity. The competition was confined to German firms, and the prize for the smaller type was awarded to the 100-horse-power Daimler motor, which is used in the new Parseval airship.



THE PARSEVAL AIRSHIP IN FLIGHT.

In the construction of this motor especial attention was given to accessibility of parts and certainty of action. In these respects the new motor is very superior to most French light motors, which often become overheated and stop in a few minutes and are rapidly worn out by friction. The Antoinette motors, for example, require extensive repairs, including renewal of valves and even cylinders, after eight or ten flights. In the German competition continuous operation during ten hours was made the minimum requirement, and the new Daimler has often been run continuously for twenty-four hours. All important parts are accessible from one side of the motor, which leaves little to be desired in ease of inspection and operation and steadiness of action.

Reduction of weight was a secondary consideration, the V-cylinder type being expressly excluded from the competition; but weight has been saved by making only the inner walls of iron and the jacket of sheet copper. The shaft and its housing are of bronze and aluminium. There are six vertical cylinders and three carbureters, each of which serves two cylinders. Owing to this innovation, the aspiration tubes are very short, and the resistance always the same, but the principal advantage is that four cylinders can continue in action when a cylinder or a carbureter is disabled. The cooling is by water supplied by a centrifugal pump, the lubrication is automatic, and the ignition is furnished by a high-voltage dynamo. At 1,300 revolutions per minute the motor develops from 100 to 120 horse-power, but the speed can be raised to 1900 revolutions, and the power correspondingly increased. The weight of the motor, including the fly wheel, carbureters, magnet, pump, and connections, is 770 pounds. It can be started by hand or by air compressed by the motor itself. The igniter can be changed in 40 seconds while the motor is running. The consumption of fuel and oil is very small. A flight of 340 miles in twelve hours can be made without refilling the gasoline tank.

The new Parseval airship made its first flight on August 14. In the second of these flights it remained aloft two and one-half hours and traveled 54 2/3 miles. On the following day it made a third ascent, and suffered a slight injury in landing. On August 20 the Parseval airship and the Basenad army balloon rose from Tegel, proceeded to Berlin, sailed together down the avenue Unter den Linden, and returned to the starting point.

In a recent flight the Parseval airship remained thirteen hours in the air. Still more recently, on September 16, it "buckled" and its ballonets collapsed in a squall, but Major von Parseval and his four companions alighted on a roof without injury.—Translated from Umschau.

THE CAR OF THE PARSEVAL AIRSHIP.

GASES IN UPPER AIR.

M. TEISSERENC DE BORT, whose work in the study of the atmosphere is well known, has been making observations upon the presence of rare gases in the upper air, especially of argon, neon, and helium. The air is taken by means of "sounding balloons" which are sent up to great heights and have an automatic device for taking a portion of air. The experiments were made to see the difference between the lower and the upper air in this respect, seeing that the lower parts of the atmosphere are stirred up by air currents, while the upper portions are formed of independent strata or superposed currents. As the usual sounding balloons are somewhat small, about 100 cubic yards, he wished to use a larger size and at the same time secure a sample of air which should be perfectly pure. He therefore devised a new apparatus for collecting the air which has no stop-cocks, grease, or chemical products. To this end he employs a glass tube (or small bulb) which is closed at one end by a small sealed projection and at the other has the arrangement for taking the air when at the required height. At this end the tube is run out to a fine point which is closed by the blowpipe after forming a vacuum in the interior. The tube is suspended and well protected. When arriving at the desired height, an electro-magnetic device operated by the barometer is used to break off the point of the tube so as to allow the air to enter. A few minutes after this, a second contact sends current from a battery through a platinum wire surrounding the base of the pointed portion and this melts the glass and thus seals the end of the tube. From the Trappes observatory he sent the balloons to various heights up to 8½ miles. All the samples show a large proportion of argon. As to helium, it is observed by the spectroscope in samples ranging from 0 to 6 miles. On the contrary, at 8½ miles he could not find the presence of helium. Neon is seen at all heights. These observations have some bearing on the rays which are found in the spectra of the aurora borealis.

A CORRECTION.

THE article by Prof. E. A. Birge on "The Respiration of an Inland Lake," which appeared in the issues of the SCIENTIFIC AMERICAN SUPPLEMENT for August 22 and 29, was reprinted from The Popular Science Monthly. We regret that proper credit was not given.

To find the weight of castings, multiply the cubic inches by 0.27 for iron, 0.29 for steel, and 0.30 for brass.

THE RESTORATION OF PARCHMENTS.

HOW THE DAMAGE WROUGHT BY FIRE MAY BE REPAIRED.

BY EUGÈNE LEMAIRE.

PARCHMENT has been known for a very long time, but it is not generally well known at present, for it has fallen from its high estate and is used only, in a very coarse form, for the backs and corners of ledgers and for similar purposes. Even university diplomas are now engrossed on vegetable parchment, which is a variety of paper.

Parchment is said to have been invented in Pergamon, in Asia Minor (whence the name parchment) about 150 B. C. as a substitute for Egyptian papyrus, with which the learned men of Alexandria refused to supply their rivals in Pergamon. However this may be, it is certain that parchment was made very extensively at Pergamon soon after this epoch. The manufacture has always been empirical, for parchment was supplanted by paper long before the modern development of technical science began.

It is to be regretted that the properties of parchment are so little known, for on the knowledge of them depends the proper preservation of the literary and historical documents of past ages. Unfortunately, also, these treasures are not always well guarded. In 1904 the national library at Turin, Italy, was partially destroyed by fire and most of the fine parchments which it contained were reduced to a deplorable condition.

To this disaster, however, we owe the only scientific study of parchment that has ever been made. Dr. Guareschi, professor of chemistry in the University of Turin, undertook the restoration of the parchments recovered from the ruins. His work included researches on the inks and pigments used by the ancients. His experiments were necessarily made on the very manuscripts which were to be restored, and to their further injury, notwithstanding every precaution. It is to be hoped that Prof. Guareschi's results will be carefully studied by librarians and paleographers, if only in order to avoid the necessity of repeating such costly experiments, for all libraries are at the mercy of fire, which is far more destructive to parchment than to paper.

The destruction of paper, even by an intense fire, is a notoriously tedious and difficult operation. A paper book does not warp in the flames, so that the interior is protected by the outer pages and is very slowly affected. If the half-burned book is drenched with water, as is apt to be the case in conflagrations, the leaves, after they have been separated and dried, are found to have regained their original form, size, and appearance. The effect of fire on a parchment book is altogether different. The volume becomes warped and consequently the heat quickly reaches the interior. Furthermore, it is only necessary to heat parchment to 400 or 500 deg. F., or to heat it to 250 deg. F. and then dash cold water upon it to produce a contraction from which there is no recovery. The diminution of area sometimes exceeds 50 per cent. A manuscript in this condition, although not totally destroyed, is nearly always so deformed and illegible as to be practically worthless.

Finally, the common belief that parchment is not subject to putrefaction is quite erroneous. It does not decay in ordinary conditions of temperature and dryness but it putrefies very quickly after it has remained damp and warm for several days in consequence of a conflagration. The parchment becomes soft and sticky in consequence of its partial conversion into gelatine. Holes then form, as illustrated in Fig. 1, and finally the sheet falls to pieces.

Fortunately, conflagrations in libraries are of rare occurrence. In modern times there have been only two conspicuous examples in addition to that of Turin. The Cotton collection in the British Museum was partially burned in 1731, and 55,000 volumes were destroyed by the fire which visited the Library of Congress at Washington in 1851. Of the 958 manuscripts which composed the Cotton collection, 114 were totally destroyed and 98 were injured. The damaged parchments were satisfactorily restored in 1824 by Forshall and Madden, who did not, however, make public the method of restoration. Prof. Guareschi thinks that these parchments could not have been very seriously damaged, as they were kept for nearly a century after the fire and were then completely restored.

FIG. 4.—A PAGE OF THE "ROMAN DE FLORIAMONT" DAMAGED BY FIRE.

FIG. 5.—THE SAME PAGE AFTER RESTORATION.

Parchment is not subjected to any process analogous to tanning. It is made of the inner skin, which is treated with milk of lime, dried on a stretching frame, and then scraped and rubbed with pumice stone for the purpose of removing all the fatty matter and making the skin thinner and softer. The last traces of grease are removed by dusting the inner surface with slaked lime and chalk. The parchment, if it is to be used for writing or drawing, is then rubbed again with pumice and, finally, stiffened with starch paste.

The fine parchment known as virgin parchment is made of sheepskin. Vellum is made of skins of unborn or still-born calves. Vellum is whiter, smoother, and more flexible than ordinary parchment and is almost transparent. In Japan a material intermediate between leather and parchment is made of ox hide by a process of currying and drying. This product, which is thick and yet supple, may be washed and is not subject to putrefaction, is employed in Germany in the manufacture of surgical and orthopedic bandages.

Although the process of tanning has formed the subject of recent scientific researches, the nature of the transformations by which skins are converted into ordinary leather, Japanese leather, parchment, and vellum is still unknown.

Parchments recovered from the ruins of a burned building are either in solid masses which resemble horn and appear to be completely carbonized and vitrified (Fig. 2) or in detached leaves which are usually wet and soiled with mud and soot (Fig. 4). The first thing to be done with the damaged parchments is to put them in such a condition that they can be preserved until their restoration can be undertaken. For this purpose it is usually sufficient to dry the parchments thoroughly and quickly by placing them on metal gratings in an aspirator. If there is any danger of putrefaction occurring during the

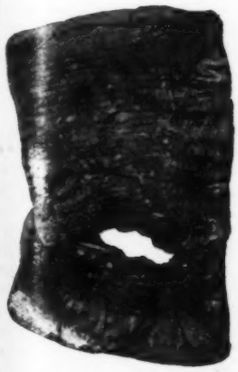


FIG. 1.—HOLES MADE IN PARCHMENT BY PUTREFACTION.

FIG. 2.—A PARCHMENT VOLUME CAKED AND VITRIFIED BY HEAT.

FIG. 3.—THE SAME VITRIFIED BOOK OPENED.

FIG. 6.—CHAMBER FOR SEPARATING CAKED PARCHMENTS BY MEANS OF WATER VAPOR

drying process, the current of air is charged with formol vapor by heating the commercial 40 per cent solution of formol inside the aspiration chamber. If putrefaction has already commenced, it may be arrested instantly by immersing the parchment in alcohol of 50 deg. Baumé, containing 2 or 3 per cent of carbolic acid.

The vitrification of parchment is due to the partial transformation of the skin into gelatine under the influence of heat and pressure, and also, in some cases, to an incipient destructive distillation and the consequent formation of Dippel's oil, a sort of animal tar which is far more adhesive than coal tar or wood tar, and is insoluble in benzine and alcohol. The tar may be softened and the leaves separated by soaking the mass in warm water, but this process is attended with the danger of washing off or blurring the inscriptions and illuminations. Better results are obtained by placing the mass, after its charred and hardened edges have been filed or scraped away, in a chamber filled with the vapor of water at from 70 to 85 deg. F. (Fig. 6). The process is slow and the conditions are very favorable to putrefaction, which must be carefully guarded against.

As each leaf is detached it is washed with warm water and a fine sponge and stretched in all directions to its original form and size. It is next laid between sheets of blotting paper fastened by its edges to a frame by means of strips of thick cardboard and thumb tacks and allowed to dry in the air. Before it has become entirely dry, however, it is placed, with several other sheets, in one of the simple presses shown in Fig. 6, in order to make it perfectly plane. It is then exposed to the air until dry.

After the leaf has been detached, all the subsequent operations can be performed in one day, if the outdoor temperature is above 60 deg. F. Figs. 4 and 5, which represent the same leaf, before and after treatment, give an idea of the results obtainable by this method. The leaf here shown is from an old and unpublished French manuscript, the "Roman de Floriamont," nearly all of which has been restored very satisfactorily.

It is impossible, however, to obtain such results with sheets that have been heated above 400 or 500 deg. F. or have been suddenly cooled by water from a temperature above 200 or 250 deg. F. In these cases the injury is almost irreparable. Sometimes one part of a sheet is found so greatly contracted that it cannot be stretched to its original dimensions, while the remainder, swollen by heat and moisture, falls into wrinkles that make the manuscript illegible when the sheet is flattened. The remedy in this case is to lay a cloth over the expanded part and press it with a hot iron until it becomes as much contracted as the rest.

Some parchments can be stretched to double the area which they showed when found in the ruins. As no parchment, ancient or modern, that has not been damaged by fire can be stretched to this extent Prof. Guareschi concludes that these very extensible parchments have been greatly shrunken by pressure experienced during the conflagration.

Parchment normally contains 18 or 20 per cent of water, not in chemical combination. When parchment is heated to a temperature lower than 260 deg. F. it loses this water, all of which it regains, however, on exposure to the air. When parchment is heated still higher it loses also part of its chemically combined water and in this case the loss is only partially made good, even by immersion in water, the deficiency being greater in proportion to the elevation of temperature.

Sometimes the effect of fire and restorative treatment is to make parchment hard and brittle. Guareschi has softened such parchments by soaking them in weak solutions of hygroscopic salts. The best results were obtained with slightly alkaline 1 per cent solutions of potash soap and potassium acetate. The soap solution has also a cleansing effect.

Finally, the colors of faded ink and of some pigments can be restored by brushing with solution of tannin or ammonium sulphate.

The red pigments found on old parchments are cinnabar (mercury sulphide) and minium (red oxide of lead). Cinnabar is comparatively little affected by the reducing action of the parchment and the gum Arabic in the ink, but a temperature of 410 deg. F. suffices to change characters written with minium from red to dull blue, owing to the reduction of the pigment of metallic lead.

The ancient blue pigments usually consist of copper salts and are often washed off by the water thrown on the fire.

It is difficult to distinguish antique from modern parchments. In general, antique parchment, incinerated in a platinum crucible, yields a light and bulky mass of charcoal which burns readily, while modern parchment produces a smaller and denser mass, which burns slowly. The best old parchments leave very little ash when burned. Some chemical change undoubtedly takes place in parchment in the course of time, for newly-made parchment is dissolved in two days by 15 to 30 per cent solutions of nitric acid of 56 deg. Baumé, which have no effect upon old parchment that has not been injured by fire.

In four months, with the aid of four assistants and without interrupting his regular university work, Prof. Guareschi restored to a fair and legible condition 3,000 sheets, constituting the greater part of the manuscripts submitted to him. Yet his conclusion is pessimistic. He finds the work of restoration so costly that he advises that injured parchments be first examined by expert antiquarians and philologists in order to determine whether they are worth restoring. Many old parchments are merely prayer books, without illuminations, full of errors, poorly written, and devoid of literary and artistic interest.

The conclusion is that prevention is better than cure. Our libraries, according to Prof. Guareschi, seem designed to invite destruction by fire. The compartments and shelves are of wood, old and worm-eaten, which could easily be made fireproof or, better, replaced by iron, which would occupy less room without increasing the weight. It is advisable to store parchments in a room that can be absolutely closed and thus protected from water, which is even more destructive than fire. In this room might be placed cylinders of liquid carbon dioxide, closed by fusible plugs which melt at 200 deg. F. The carbon dioxide which is released when this temperature is attained would not only preserve the parchments from destruction, but would check the conflagration by its inability to support combustion and the intense cold produced in its vaporization and expansion. This expedient has been found successful in preventing fires in coal stored in great quantities.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

THE PROBLEM OF THE ROTATION OF VENUS.

DOES THE PLANET REALLY TURN?

BY OTTO HOFFMANN.

THE planet Venus, always the brightest star in the heavens, occasionally shines with extraordinary brilliancy. At Cherbourg in April, 1905, it appeared as a bright meteor of appreciable size and oval form—an effect which was partly due to the formation of a halo.

Venus has often been seen in full daylight, and in 1797 Napoleon, returning from his conquest of Italy, found the Parisian populace so absorbed in the contemplation of the beautiful planet—at high noon—that they had no eyes for him and his glittering retinue. On moonless nights Venus sometimes casts distinct shadows.

The great brilliancy of Venus is due to its relatively small distance from the sun and the earth and to its great reflecting power. The albedo of Venus, or the ratio reflected to incident light, is 0.76. In other words, the planet reflects three-fourths of the sunlight that falls upon it, a proportion which is little exceeded by freshly fallen snow. This indicates that Venus is surrounded by a dense and cloudy atmosphere, and similar indications are given by the spectroscope. The strengthening of the tellurian lines in the red and the appearance of additional absorption lines point to the existence of an atmosphere containing water vapor and generally similar to our own, but denser.

The atmosphere of Venus, owing to its great refractive power, sometimes appears as a luminous ring in transits of Venus. At the last transit, in 1882, this phenomenon was seen by many observers, both at the entrance of the planet upon the sun's disk and at its emergence. At the Alleghany observatory Langley and Keeler, using different telescopes, observed a broad bright aren extending inward from the ring. In 1874 Lyman saw the crescent of Venus extended to form a closed ring five hours before the transit, and extended to 232 deg. three days later. These phenomena were unquestionably due to refraction by the atmosphere of Venus. Lyman estimated this refraction as 54 minutes of arc. Hence it follows that the density of the atmosphere of Venus is 1.8 that of the earth's atmosphere, which produces a refractive displacement of 33 minutes. According to Maedler's calculations the atmosphere of Venus is 1.7 times as dense as ours.

Hence we may regard as proved that Venus is surrounded by a dense atmosphere into which the sun's rays do not penetrate to a depth sufficient to cause much loss by absorption—probably because they are reflected by opaque clouds. From this it follows that the markings which have been observed on the disk of Venus for centuries may be purely atmospheric and consequently that all estimates of the period of rotation that have been deduced from observations of the markings may be completely illusory.

The markings of Venus are altogether different from those of any other planet. They are faint, indistinct and apparently variable, for the drawings of Venus made by different observers are very unlike. Certain markings of Mars, on the contrary, have been seen and recognized for two hundred years, and even the spots and bands of Jupiter, which are probably atmospheric, are less variable than the markings of Venus.

The first astronomer to observe any markings on Venus was Domenique Cassini, who discovered a bright spot in 1666. In the following year he discovered a second spot, which he observed for several months, during which it remained nearly stationary. From his observations of the spot he deduced a period of rotation of about 24 hours, an estimate which was reduced to 23 hours and 22 minutes in Jacques Cassini's revision of his father's work. On the other hand, Bianchini, who studied the planet in 1726-1727, deduced from his observations a period of rotation equal to 24 days and 8 hours.

Thus began the long and violent controversy in regard to the rotation of Venus. In the following century the question was decided, temporarily at least, by De Vico, in favor of the advocates of a short period. From more than 10,000 observations made between 1830 and 1841 De Vico computed a mean value of 23 hours, 21 minutes, and 23.93 seconds for the period of rotation of Venus. This value, furthermore, agrees very closely with the period of 23 hours and 21 minutes deduced by Schroeter from observations of the deformation of the horns of Venus (1788-1793) and it has consequently been adopted by most treatises on astronomy.

In 1890, however, belief in the short period was shaken by Schiaparelli's discoveries. Before this, Schiaparelli had made the surprising announcement that the period of rotation of Mercury was equal to the period of its revolution about the sun, and he now asserted that the same law governed the motions of Venus. This statement was based on observations made in the winter of 1877-8, which showed that the bright spots then visible never varied their positions with respect to the terminator. Observations made in 1895 gave additional support to the view that Venus rotates on her axis in the period of her revolution about the sun (225 days), and consequently always turns the same hemisphere toward the sun, as the moon always presents the same face to us.

This theory, which on its announcement rested solely on Schiaparelli's authority, soon obtained independent support. For example, the spots appeared in exactly the same positions in a drawing made by Holden in Washington, 1877, and in one made by Schiaparelli eight days earlier. A long period of rotation had been indicated by observations made by Vogel and Lohse in 1871. Schiaparelli's theory has obtained additional support from the observations of Perrotin, Tacchini, Terby, Mascari, and Cerulli, and it has apparently been completely confirmed by the observations made by Lowell at Flagstaff, Arizona, in 1895-6. Lowell's observations were made with a 24-inch objective and magnifying powers of 140 to 300, and they were favored by a very clear sky and pure air. Lowell saw markings that have been seen by no other astronomer, before or since, but the most surprising thing about his discoveries is that he saw no spots, but only bands or lines bearing a superficial resemblance to the canals of Mars. The whole configuration remained unchanged for hours, which could not be the case if the period of rotation were only 24 hours. Furthermore, the markings remained fixed relatively to the terminator. Lowell denies the

existence of clouds on Venus, although he finds in certain phenomena of twilight evidence of the presence of a very dense atmosphere.

As Lowell also claimed to have seen lines resembling canals on the third satellite of Jupiter his discoveries have been rejected as optical illusions by his opponents. The configurations marked on Lowell's map of Venus have been seen at no other observatory, although they bear a distant resemblance to some drawings of Pontséré of Barcelona.

Many astronomers have refused to accept the conclusions of Schiaparelli, Perrotin and Lowell, and have adhered to the theory of a short period of rotation. Schiaparelli's first announcement was vigorously disputed, soon after its publication, by the French astronomer Trouvelot. Trouvelot's observations of Venus extend over a period of nearly twenty years, those of the first seven years being made at Cambridge, U. S., and the others at Meudon, near Paris. During his residence at Cambridge, from 1875 to 1882, Trouvelot pointed out seventeen changes in the markings which Schiaparelli, observing at the same period, regarded as fixed. Trouvelot regarded the bright spots on the limb of the planet as very high mountains, rising above the atmosphere.

The observed changes in the appearance of the horns of the crescent planet have also been ascribed to mountains. In the eighteenth century Schroeter announced the discovery of several mountains on Venus. In 1789 the southern horn of the crescent appeared blunted and near it on the dark disk of the planet shone a bright peak, the height of which was estimated by Schroeter as 117,000 feet, or 22 miles. Trouvelot deduced from his own observations a period of rotation of about 24 hours. It is very remarkable that two such experienced and reliable observers as Schiaparelli and Trouvelot could be led to such widely differing results from their frequent observations of the same object during the same period.

Trouvelot's contention was sustained by Niesten and Stuyvaert, Stanley Williams and Leo Brenner, all of whom deduced from their own observations periods of about 24 hours.

Loeschardt, after a critical examination of earlier observations and his own made in Hungary in 1890, has also upheld the theory of rapid rotation.

On the other hand, Wislicenus and Flammarion, after exhaustive study of the subject, have arrived independently at the conclusion that all observations of markings are too uncertain to form a basis for the calculation of the period of rotation. The markings have very seldom been drawn in the same way by observers in different places, even at the same time. There is great similarity between a drawing made by Stuyvaert in Brussels and one made by Villegir in Munich, and between one made by Rudaux in France and two made by Capt. Molesworth in Ceylon. There are a few other strong resemblances between nearly simultaneous drawings, but it is always nearly or quite impossible to identify a marking in drawings made at different times.

It may be regarded as certain that the problem of the rotation of Venus cannot be solved by observing markings, and this is not surprising when we consider that the markings are purely atmospheric phenomena.

Sir William Herschel, who has justly been called the greatest observer of all time, doubted the reality of the markings of Venus. He often observed faint, blurred, and variable spots on the crescent of Venus, near the terminator, or boundary between light and darkness, but they appeared too indistinct and too evanescent to furnish data for the determination of the period of rotation or the position of the axis. Herschel correctly regarded the markings as atmospheric phenomena, but this view was not shared by any of his contemporaries. Beer and Maedler, who were also most excellent observers, studied Venus repeatedly in 1833 and later years, but they rarely, if ever, saw anything that deserved the name of a marking.

Attempts have been made to solve the interesting and difficult problem of the rotation of Venus with the aid of the spectroscope, but these attempts have also failed to give a positive result. The velocity of a luminous body in the line of sight can be calculated, on Doppler's principle, from the displacement of the lines of its spectrum. A movement of one kilometer per second can be detected in this way by very exact measurement of the displacement. This method has been employed in determining the motions of stars and the period of rotation of the sun. The Fraunhofer lines are shifted slightly toward the red end of the spectrum when the spectroscope is directed to the receding limb of the sun, and toward the violet end when the instrument is directed to the advancing limb. Thus the velocity of rotation of the sun's equator was found by Vogel nearly forty years ago to be about 2 kilometers per second, in exact accordance with the value obtained from observations of sun spots. The proof that the inner parts of Saturn's rings rotate more swiftly than the outer parts has recently been obtained by the same method.

But when this method was applied to the rotation of Venus, it gave contradictory results. A period of rotation equal to 24 hours corresponds to an equatorial velocity of 450 meters per second, and therefore to a difference of 900 meters per second between the velocities of the advancing and receding limbs. This difference is scarcely great enough to be detected by the spectroscopic method as it is usually practised. Furthermore, the observations must be made when the entire illuminated hemisphere of the planet is turned toward the earth, and this occurs only at superior conjunction, when Venus is beyond the sun and at a very small angular distance from it. Hence the observations must be made in the brightest sunlight on a very clear day, and with the most perfect and delicate of instruments. The attempt was first made by the Russian spectroscopist, Bjelopolsky, at the Pulkowa observatory. The spectrophotographic measurements, which were begun in 1900, indicated a short period of rotation. Although Bjelopolsky did not regard the correctness of the result as assured, his authority led to the belief that the spectroscope had decided the question in favor of the short period.

Then Lowell, who had deduced a period of 225 days from telescopic observations, sought confirmation for this value by the spectroscopic method. A very powerful telespectroscope was constructed by the world-renowned firm of Brashear & Co. for the work on Venus, which was carried out in 1902, chiefly by Slipher. The iron lines were selected for comparison and the slit was placed at first parallel, but afterward perpendicular to the assumed direction of the equator of Venus. With the slit in the former position and covering an equatorial belt including portions of both the advancing and receding limbs, the effect of rapid rotation would be to displace the ends of each spectral line in opposite directions without affecting the middle. Thus would be produced an inclination of the lines which can be more easily measured than mere lateral displacement. Lowell tested his apparatus and method by applying them to Mars and thus obtained for that planet a period of rotation of 25 hours and 35 minutes, which agrees fairly well with the known period, 24 hours and 37 minutes. For Venus, Slipher's spectrophotographs give an equatorial rotational velocity of from 5 to 8 meters per second, which corresponds to a long period of rotation, though one much shorter than 225 days, for which the equatorial velocity would be about 2 meters per second.

Neither of the results obtained at Pulkowa and at Flagstaff has yet been confirmed elsewhere. The spectroscopic method is too difficult to be attempted except by a particularly well equipped and favorably situated observatory. The theory of slow rotation receives powerful support from certain cosmogenetic arguments advanced by the eminent English astronomer, G. H. Darwin. The rotational velocity of every planet must be gradually diminished by tidal friction among its parts. In this way the period of the moon's rotation has been made equal to the period of her rotation about the earth, and the rotational periods of Mercury and Venus may have been similarly lengthened to equality with their periods of revolution about the sun, which exerts a far greater tidal action upon these inferior planets than upon the earth.

If Venus has already reached this stage, all the water on the planet must be accumulated in the form of ice on the dark and intensely cold hemisphere. Hence, as Antoniadi has pointed out, the presence of clouds and water vapor on the illuminated hemisphere casts grave doubt on the correctness of Schiaparelli's theory. The presence of clouds in the atmosphere of Venus is denied only by Lowell, who saw the peculiar canal-like markings distinctly whenever terrestrial atmospheric conditions permitted. No trace of markings, by the way, was seen by Hansky and Stefanik, who observed the planet last summer (1907) from the Mont Blanc observatory, which is more elevated than Flagstaff, under very favorable atmospheric conditions, and deduced a period of rotation slightly less than 24 hours.

So the problem of the rotation of Venus is still unsolved, although a majority of astronomers appear to share the view of Schiaparelli and Lowell. The hope that it can be solved by observing markings has proven illusory, but there is good reason to believe that the spectroscope will ultimately furnish the solution.*—Prometheus.

An authority states that the best test for cylinder oils is to heat them in a current of air for one hour at the temperature corresponding to the steam pressure at which they are to work. The loss in weight should not exceed 0.5 per cent.

* It seems only fair to point out that great elevation is not the only desideratum for an observatory, that the extensive arid plateau of Arizona is very unlike the snow-clad, glaciated and storm-swept Alps, and that Lowell's spectroscopic method, which takes cognizance of a few meters per second, could not have failed to detect the rotational velocity of 450 meters per second entailed by the 24-hour period.—[Editor.]

STUDIES OF MEAT EXTRACTS AND SIMILAR PREPARATIONS.

A MONOGRAPH has been issued by the Department of Agriculture on "Meat Extracts and Similar Preparations," by W. D. Bigelow, chief of the division of foods, and F. C. Cook, physiological chemist. The conclusions are as follows:

It is commonly assumed that proteids, gelatinoids, and the simpler amids have very different nutritive values, and, while all authorities would agree in assigning the highest value to the first of these, there is probably no small difference of opinion as to the order in which the second and third should be rated. In considering such a question, there should be separately taken into account relative digestibility or solubility, capability of undergoing osmotic absorption, and oxidizability for the production of energy. At present, no definite numerical statement of the relative nutritive values of nitrogenous bodies of these three classes can be made. It seems much to be desired that more extended experiments than have so far been recorded should be made upon living animals (as far as possible upon human beings) to determine the utilization of both the gelatinoids and the simpler amids. The latter no doubt undergo oxidation to some extent in the animal body, and produce some energy in consequence. It is probably true of these simpler amidic substances that much larger quantities than analysis exhibits as constituents of the food consumed, or than analysis detects among the residue of food rejected from the body without having undergone complete oxidation, may be constantly formed among the earlier products of the metabolism of the proteids, and afterward themselves undergo further change into the simpler and more stable forms of carbon dioxid, water, and urea.

In the animal body the amido acids are acted upon in two ways; that is, they are converted into the corresponding fixed acids or carbonic acid is split off, leading to the formation of Brieger's diamins, or it is possible for both of these processes to take place. Usually the albumins are converted in the alimentary tract by the four proteolytic ferments (pepsin, trypsin, erepsin, and arginase) into primary crystalline dissociation products, namely, the amido acids, which are absorbed in this form. Whether a part of the albumin taken as food can or can not be absorbed in the form of albumoses, peptones, and peptids remains to be determined.

Meat preparations are largely used by the sick and the young. Their use is recommended frequently by physicians who may not have taken the trouble to ascertain the true nutritive value of the product prescribed. It seems to be the consensus of scientific opinion among scientific investigators who have studied this question that the food value of these meat extracts is rather limited, and although they are a source of energy to the body they must not be looked upon as representing in any notable degree the food value of the beef or other meat from which they are derived. When prepared under the best possible conditions a commercial meat extract is, of necessity, in order that it may not spoil, deprived of the greater part of the coagulable proteids, which constitute the chief nutritious elements of the juice. It is fair to state that many manufacturers make no claim as to the food value of their preparations, only a comparatively few making extravagant statements as to the nutritive value of these products.

Preparations of this character are not wholly valueless in the sick room, for they possess stimulating qualities, and in the kitchen they are useful on account of their flavoring properties. They are not, however, concentrated foods, having on the contrary but comparatively little nutritive value. The meat juice prepared from fresh meat, in the home or hospital, by continued heating at a low temperature, is far superior as a food to the commercial meat extracts and so-called meat juices.

Process of Decolorizing Fats.—Chlorine and peroxide of hydrogen have been used repeatedly for the bleaching of fats, without the attainment of satisfactory results. The recent invention of A. Marcellin facilitates the employment of chlorine cheaply and with success. In a vessel capable of being heated, up to 100 parts of the fat to be decolorized, about 100 parts of caustic potash solution, of 4 deg. Bé., and about 10 parts of soda solution of equal strength are placed, the whole stirred and heated. Shortly before the fluid begins to boil, according to the depth of color of the fat, 3 to 10 parts of chloride of lime, mixed in 50 parts of water, are added. Allow it to boil until the greater part of the water is evaporated, when an emulsified, partly saponified, completely decolorized substance will be obtained, which may be employed directly in the manufacture of soap, or by decomposition, the soap formed may be reconverted into a pure fat substance. The bleaching is effected in the ordinary apparatus, stirring by means of a stirring apparatus or by centrifugal pumps.—Revue de Chimie Industrielle.

SCIENCE NOTES.

In a recent issue of the English Mechanic and World of Science, it is stated that at the June 15 meeting of the Academy of Science, Mr. Devaux Charbonnel gave particulars of a method of photographing sounds in the human voice, in such a manner that the photographic record could be read. Vowels and consonants are combined by means of the Blondel oscillograph. This extremely sensitive instrument impresses the sounds upon a photographic plate in the form of curves, which can, with a little practice, be easily deciphered.

The greatly enhanced use of fluor spar as a flux in metallurgical works during the last few years has led to great development in the mining of the mineral, and it may not be without interest to say a few words on the subject, more particularly with regard to Derbyshire, where the augmentation in the output is so striking. Although fluor spar, which is the fluoride of calcium, is found to some extent in other geological horizons, it is nowhere so abundant as in the carboniferous limestone and its associated Yoredale beds, and the whole of the present British production comes from these strata, where it is found as the gangue of metalliferous veins. It is usually associated with calc spar, quartz, or barytes, though this is not universally the case. The present importance of the mining industry will be at once apparent when we compare the output of only a few years ago with the figures for 1906, which are the most recent ones available:

	Tons.		Tons.
1898.....	56	1903.....	11,911
1899.....	783	1904.....	18,160
1900.....	1,448	1905.....	39,446
1901.....	4,214	1906.....	41,849
1902.....	6,287		

Until 1902 the bulk of the output came from Durham, from the mines of the Wearcale Lead Company, but since that year Derbyshire has gone rapidly ahead, and Durham now takes the second place.

The Didaskalia states that the so-called Welsbach mantles for gas-light were hitherto prepared by saturating the mantles of woolen or ramie fiber with a solution of rare earths, which produce the increased light. Experiments to substitute silk, hemp, or jute proved unsuccessful. Artificial fibers did not become saturated or insufficiently so. According to the Moniteur Scientifique an artificial fiber has now been found which in all respects is equal to wool or ramie, namely, artificial silk, which is produced by dissolving cellulose in an ammoniacal copper solution. Only the nitrate of thorium does not answer well as a saturant. While artificial silk becomes impregnated with a solution of that salt, the oxide of thorium formed through incineration scales off and nothing but a bit of powder remains. Therefore instead of nitrate of thorium, hydroxide of thorium must be used, which after incineration leaves a perfect, solid skeleton of hard little crystals. As, however, hydroxide of thorium is of a gelatinous consistency, the mantle of artificial silk cannot be impregnated with it, and therefore it is first saturated with nitrate of thorium, and, through the action of ammonia, hydroxide is formed upon the fiber. One of the greatest advantages of this new mantle is that it is not hygroscopic and is of greater durability. Experiments have demonstrated that even two to three thousand shocks do not injure it, while the best mantles prepared by the old methods did not survive more than 90 to 100 shocks.

It has been one of the accepted doctrines of physiology in the past that in the animal body the protein of tissue protoplasm is the result of a simple transformation of the food protein; digestion in the gastro-intestinal tract leads to the formation of proteoses and peptones, which after absorption are reconverted into such proteins as are adapted to the needs of individual organs and tissues. Latterly, however, this view has been steadily losing ground. The discovery of the enzyme erepsine in the intestine of man and the higher animals, together with its well-established power of quickly breaking down peptones into crystalline fragments, among which the diamino acids stand out conspicuously, has raised the question whether in the intestine prior to absorption food protein is not more or less completely disintegrated with formation among other fragments, of arginine, lysine, and histidine, out of which in the liver or elsewhere specific proteins are manufactured *de novo* to meet the needs of the individual organism. There are many grounds for attaching considerable weight to this view, although the question is by no means settled. The facts, however, point clearly to the probability that in digestion the food protein is more or less broken down into amino acids and very simple peptides, and if the organism is to derive advantage from these nitrogenous fragments for the manufacture of protein to make good tissue waste, then synthesis must be the rule. Further, it is easy to see how by such a method of procedure the animal body is able to construct by a proper selection of these fragments the specific proteins needed by different types or species of organisms; far more easily, indeed, than if the changes undergone by the varying food proteins during digestion are limited to such slight transformations as are involved in peptonization, etc.

ENGINEERING NOTES.

A process for protecting iron and steel from rust has been invented and patented by Mr. T. W. Coslett, of Temple-row, Birmingham. This consists in immersing the article in a hot phosphorized solution containing an iron compound. The surface of the iron is converted into a mixture of ferrous and ferric phosphates, and presents a pleasing dull-black appearance. This process makes the iron highly resistant to corrosion, and is being applied to all kinds of light engineering work, such as cycle frames, gun barrels, stampings, and press work.

The most powerful existing turbine is a 12,000 horse-power turbine designed and built at the shops of Franco Tosi, at Legnano, Italy, for the central electrical station of the city of Buenos Ayres, Argentine Republic. It is a Parsons turbine, with a low-pressure compensator of the Fullagar type. Normally this turbine develops 12,000 horse-power, but is able to furnish 14,200 horse-power for two consecutive hours. The steam enters under a pressure of 12 kilogrammes per square centimeter superheated to 300 deg. C. It makes 750 revolutions per minute. It is directly coupled to a three-phase Brown-Boveri 12,000-volt alternator. The total weight of the turbine, alternator, and exciter is 370 tons. One of the peculiarities of the turbine, besides its great dimensions, is the vacuum retained in the condenser even after prolonged use of the turbine.

Some new fireboats for Chicago have recently been ordered and are designed on the turbo-electric drive principle. Although the turbo-electric drive has been advocated for large liners, it has been left to smaller craft to be the first to adopt the new method of propulsion. The idea of the combination is that a high-speed—and therefore small, cheap, and economical—turbine should be used to drive a high-speed electric generator which in its turn would supply current to slow-speed motors on the propeller shafts. The advantages of the arrangement for ocean steamers have yet to be established, but for the particular service for which the Chicago fireboats are required the arrangement has, it is claimed, special recommendations. The same turbines serve to drive both generators and centrifugal fire pumps, thus saving special pumping engines, and it may be said that the boat seldom requires much power for propulsion while actually engaged in pumping. The experiment, for such it is, will be worth watching, although it has not much bearing on the larger problem of the application of the turbo-electric drive to ocean steamers.

An important departure in the design of submarines has been made in the new craft of this class for the British navy. Hitherto the general lines of the design have been somewhat of the form of an elongated cigar tapering fore and aft and with a light deck structure and conning tower mounted amidships. It has been realized, however, for a considerable time past that this design possessed many disadvantages, the greatest of which was the confined space within, cramping the movements of the crew. This was attributable to the large amount of space requisite for the accommodation of the trimming tanks and the oil storage tanks. The new type or "D" class as it is officially called, which has recently been launched from the yards of Vickers, Sons & Maxim, comprises three structures built side by side and forming one unit. Centrally placed is the submarine proper, conforming to the general elongated craft with tapered ends, but on either side, like outriggers, are placed two smaller cylindrical structures about half the length of the central section. These are utilized for the trimming and fuel tanks. Moreover, no superstructure is carried, so that when traveling awash the top of the hull is flush with the level of the water. The vessel is propelled by twin screws and carries four torpedo tubes, two forward and two aft. The propelling machinery comprises heavy oil motors, which experiment has demonstrated to be more efficient and powerful as well as safer than the lighter engines using the more volatile and dangerous gasoline fuel. The propelling machinery is also more powerful than has yet been placed in a British submarine, while similarly the vessel exceeds all others so far constructed in dimensions. The greatest secrecy has been observed in its construction, and no details concerning the craft have been permitted to be published. The design has been evolved conjointly by Vickers, Sons & Maxim, who hold the Holland patents, and the Admiralty, and is the outcome of a prolonged series of experiments and investigations that have been conducted by the combined authorities. Though the "D1" constitutes practically an experiment, it is stated that the broad lines of the design will be adopted in future submergible craft for the navy. Already the existing craft are gradually being modified and improved as occasion arises, especially in regard to the propelling equipment.

TRADE NOTES AND FORMULÆ.

Finish for Canvas, Buckskin Shoes, Soldiers' and Ladies' Belts.—Boil 1.36 parts of bleached shellac and 0.68 part of pulverized borax in 13.61 parts of water, until complete solution is obtained, stir in 0.085 part of soft soap, 4.540 parts of pipe clay, and 0.056 part of ultramarine, mix well, and strain through a fine sieve.

Cement for Attaching Enamel Shields to Marble Slabs.—For attaching enamel shields to marble slabs, the following cements are suited: I. 2 parts of finely crushed quartz and 1 part of finely ground heavy spar, or 3 parts of finely ground glass and 2 parts of finely crushed fluor spar, are mixed with silicate of soda to a thick paste and used at once. If in place of the soda water-glass, potash water-glass is used, the cement will harden much more rapidly. II. The following solutions are prepared warm, best of all in the water bath: (a) 2 parts of steeped isinglass, 8 parts of 96 per cent alcohol; (b) 2 parts of mastic, 1 part chloride of ammonia, 12 parts of 96 per cent alcohol. Both solutions are thoroughly mixed while warm. When used, the cement and the article to be cemented must be heated; the cement is applied in a thin layer. III. A well-known solution of gutta percha in chloroform, known as traumaticine, mixed with concentrated water-glass solution, is used for cementing.—Keramische Rundschau.

To Impart an Old Appearance to Gold and Silver Articles.—The most important point, in giving gold and silver articles an old, worn appearance, is to expose them to abrasion. They may be shaken up with some nails in a suitable container, the gold goods placed in dilute sulphide of ammonia, the brown spots that occur polished with spirit of sal ammoniac and powdered pumice and the high places rubbed bright with Turkey leather. Finally, dilute printers' ink with oil of turpentine and apply the mixture with a brush, so that it settles in the hollow. The whole must now be cleansed again, so that not all the black substance and spots will be removed. When silver articles that are gilded are to look like fire-gilded objects they must be carefully scratch-brushed before the electrogilding, then touch them with the fingers, previously smeared with wax dissolved in turpentine, that the high places, at least in part, are rendered non-sensitive to the gilding. They are then heavily electroplated; the articles are then placed for a few minutes in nitric acid diluted with water, whereby the high, poorly gilded spots are attacked and the silver showing underneath is etched a dark color, then treat these articles as previously described in the case of gold.—Werkstatt.

Fireproof paint for the protection of wood, that is exceedingly cheap, is made as follows: 25 parts of ground heavy spar, 1 part of dry zinc white, 20 parts of water, and 25 parts of water glass. The ground heavy spar is thoroughly incorporated with the zinc white, and this mixture is mixed with the water to form a paste, to which the water glass is finally added. As the latter is very pale, the water and glass paint thus prepared appears almost white. With this whitish paint, which during use must be frequently stirred, so that the heavy pigments do not settle to the bottom, the wood is painted, with a brush, to saturation, and this first coat, which will be dry after the lapse of 15 minutes, must be about twice repeated. Only as much color must, however, be mixed, as will suffice for one, or at most three days' painting. When, in place of the zinc white red, yellow, blue, green, black, etc., are desired mineral colors are used, in the proportion of 100 parts of heavy spar, 60 parts of a color and 40 parts of water and mixed with so much water that the color flows freely from the brush; these paints will be just as good as that above described, provided that they are used as the first and only coat.

TABLE OF CONTENTS.

PAGE

I. AERONAUTICS.—The Improved Parseval Airship.—2 illustrations 20

II. ASTRONOMY.—The Problem of the Rotation of Venus.—By Otto Hoffmann. 20

III. BIOLOGY.—The Movements of Plants.—I.—By Francis Darwin, M.A., Ph.D., LL.D., F.R.S. 20
Fever in Plants... 20

IV. ELECTRICITY.—An Electrically Operated Gas Plant.—4 illustrations.—By Dr. Alfred Gradenwitz. 20
Testing Direct-current Dynamos.—By E. S. Lincoln.—7 illustrations. 20

V. ENGINEERING.—The Leinweber Process of Extracting Oil from Boreholes.—1 illustration. 20
Rebuilding of a Sunken Bridge Abutment with Concrete Steel. 20
Liquid Fuel.—By Charles L. Hubbard. 20

VI. GEOLOGY.—Radio-active Changes in the Earth.—By the Hon. Robert John Strutt, M.A., F.R.S. 20

VII. MINING AND METALLURGY.—Saw Annealing by Electric Arc.—1 illustration. 20

VIII. MISCELLANEOUS.—The World's Lumber Trade. 20
Training the Man Behind the Gun.—9 illustrations. 20

IX. NAVAL ARCHITECTURE.—The Modern Battleship Controversy. 20

X. PHYSICS.—Gases in the Upper Air. 20

XI. SANITATION AND HYGIENE.—Studies of Meat Extracts and Similar Preparations. 20

XII. TECHNOLOGY.—The Restoration of Parchments Injured by Fire.—By Eugene Lemaire.—6 illustrations. 20